PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

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The Soil and Water Conservation Research Branch works in cooperation with the State Agricultural Experiment Stations.

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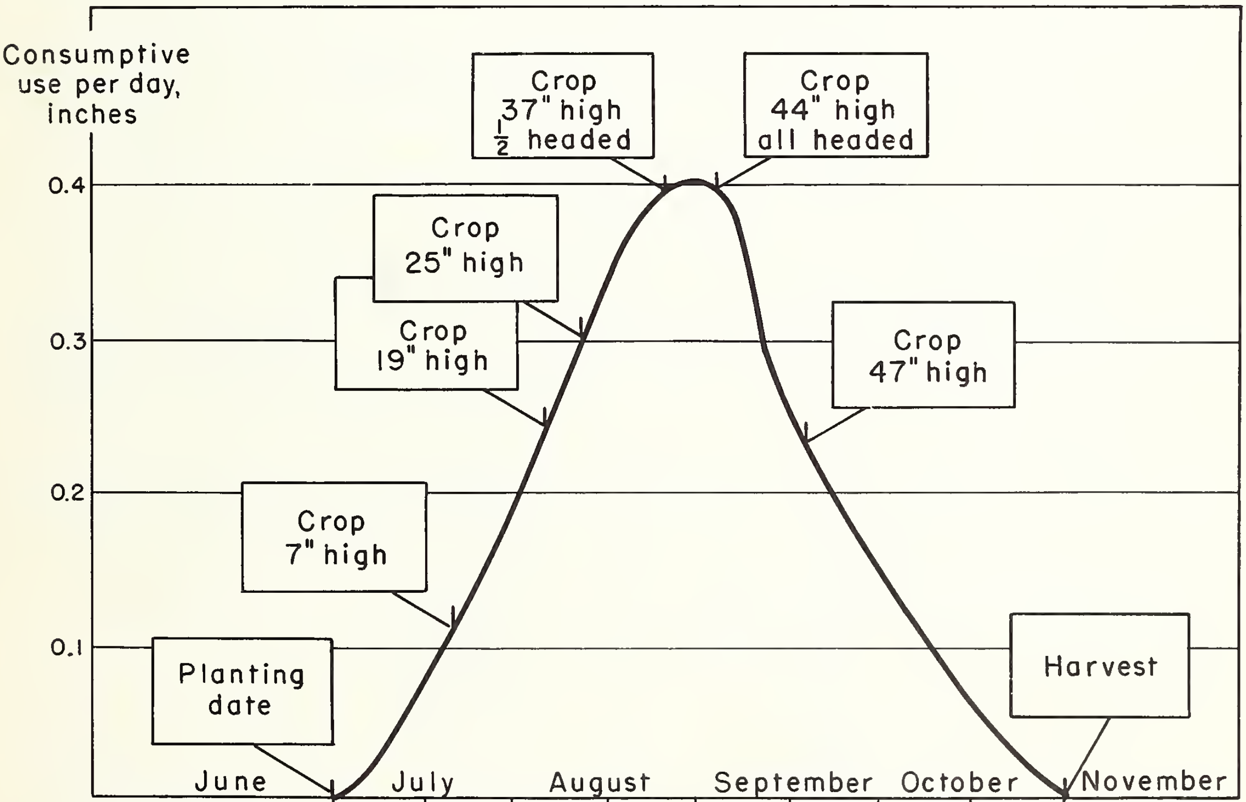
IRRIGATION

Arizona

SORGHUMS NEED LOTS OF WATER AT BOOT AND EARLY HEADING STAGES

Leonard J. Erie and Karl Harris, Phoenix.--Plantings of two common varieties of sorghum (caprock and hegari) at two locations in the Salt River Valley indicate the plant requires large quantities of water while producing abundant leaves (early boot stage) and until heads are out. The consumptive use then seems to be sharply curtailed, and a gradual decrease follows until maturity. On the soils used for these plantings, sorghum took 78 percent of its consumptive use needs from the top half of the root profile and 54 percent from the top quarter. The curve in the accompanying chart depicts the average consumptive use by two varieties of sorghum at two locations near Phoenix.

Consumptive Use of Water by Sorghum*
Salt River Valley-Maricopa County
1955



Consumptive use (inches)	July		August		September		October		
	0.48	1.88	3.90	5.87	4.95	2.88	1.95	0.45	Total 22.36
	2.36		9.77		7.83		2.40		

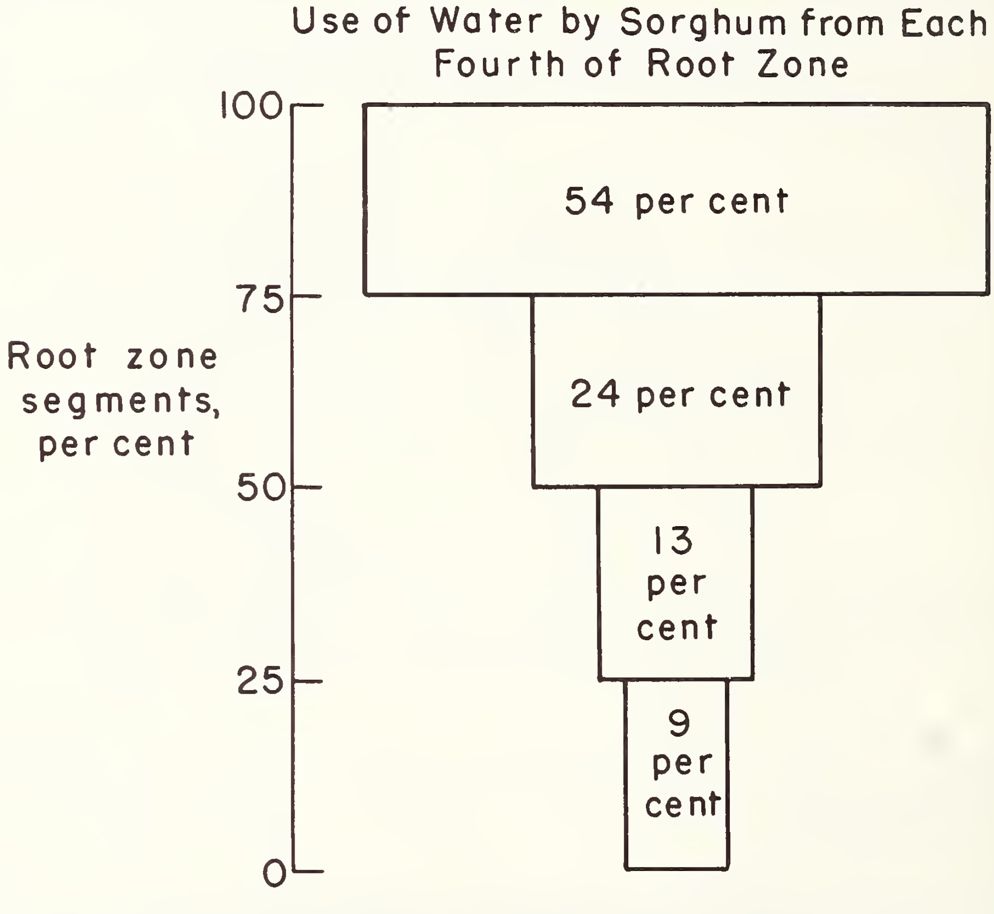
*Average for Caprock and Hegari varieties; height figures refer to Caprock

Figures on use in each 15-day interval provide us with a guide for our irrigation schedule. With grain sorghum planted July 1, on a silt loam soil following a deep

pre-planting irrigation, we can supply the consumptive requirements of a sorghum crop in the Salt River Valley with three 5-inch irrigations applied at two-week intervals, starting about Aug. 10. If light rains occur before Aug. 10, a later starting date could be justified.

It should be kept in mind that we may be justified in irrigating for purposes other than consumptive use, such as: leaching of salts, temperature control, and seed germination.

During 1954, approximately 175,000 acres of sorghum were grown in Arizona. Nearly half (81,000 acres) was grown in Maricopa County. Many producers irrigate a grain sorghum crop seven or eight times, thus wasting scarce irrigation water and increasing the cost of production. Considerable improvement on present irrigation schedules for this crop could be made by utilizing preliminary information such as that described, even though more ideal and scientific schedules will be forthcoming as research progresses. The above information was obtained for and will be used in setting up a sorghum irrigation experiment to clarify reasons for irrigating, other than to meet consumptive use needs. The experiment will also shed more light on correlating the irrigation regime with the growth stages of the crop plants.



Arizona

WHAT'S UNDER "SANDY SOIL" MAY CHANGE IRRIGATION PLANS

Leonard J. Erie, Phoenix.--Studies of the Wellton-Mohawk mesa soils are being continued on the Wellton Development Farm and have been expanded to other areas on the mesa.

The stratified material underlying many of these soils that appear to be sandy loam must be critically evaluated in relation to the design of the irrigation system and management of the irrigation water. Clays, silts, very fine sand and coarse sand layers exist at varying depths below the generally sandy top soil. The permeability of these various soil strata may vary from very slow to very fast. It is quite possible that on some soils in the area, irrigation system design should be for clay or silt-textured soil instead of for a sandy loam. Moreover, the studies indicate that during the early growing season, management of the irrigation water should be based on the coarse-textured characteristics of the surface soil. This stratified condition also exists on soils on the Fort Mohave area near Needles, Calif.

Irrigation water intake rates are now being determined for the individual stratum materials. This information and the knowledge of what textural stratum actually predominates, and its location on each field, will aid in the design of a better farm irrigation system and in the development of a more efficient irrigation water management plan.

Limited surveys indicate these strata exist at varying soil depths within very small areas; therefore, considerable judgment must be exercised in arriving at final decisions.

California

MORE, BIGGER CANTALOUP ARE RESULT OF MORE FREQUENT IRRIGATIONS

Karl Stockinger, Brawley.--During 1953 and 1954, irrigation, variety and fertility experiments were conducted on early melons started under hot caps at the Southwest Irrigation Experiment Station. The two main objectives of the experiments were to study the effect of different irrigation and fertilization practices on productivity and on the "crown blight" disease.

Because of the high natural fertility level of the experimental area, no yield responses were obtained from the fertilizer treatments.

In 1953, the basic moisture treatments were a wet treatment, (irrigated when the moisture tension of the soil at the 8-inch depth reached 2/3 atmosphere), growers' practice (the irrigation practice of one of the better growers), and dry (irrigated when a gypsum block at the 8-inch depth gave a reading of 25,000 ohms). Two varieties, PMR No. 6 and PMR No. 450 were used.

The yield of large-sized melons in crates per acre for these moisture treatments and varieties in 1953 was as follows:

Soil moisture level	Irrigations	Yield per acre	
		Variety PMR 6	Variety PMR 450
	Number	*Crates*	*Crates*
Wet..................	13	99	177
Growers' practice.....	12	96	143
Dry..................	6	42	69

It is interesting to note the large increase in yields due to more frequent irrigation in the PMR 450 variety as compared to PMR 6. Apparently PMR 6 has a low yield potential and is less responsive to more favorable environmental conditions. The premature senescence of cantaloup plants which has been called crown blight was reduced by the

wet and growers' practice treatments as compared to the dry treatment. PMR 6 variety was much more affected by the blight.

The 1954 experiment had four basic moisture treatments: (1) A very wet treatment (irrigated when the moisture tension at the 8-inch depth reached 1/3 atmosphere): (2) A wet treatment (irrigated at 2/3 atmosphere tension); (3) A medium treatment (irrigated at 2 atmospheres tension); (4) A dry treatment (irrigated at 6 atmospheres tension). Three varieties; PMR 5, PMR 450 and SR 91, were tested under these conditions.

The 1954 yields of large-sized melons in crates per acre for these treatments were:

Soil moisture level	No. of irrigations	Yield per Acre		
		Variety PMR 5	Variety PMR 450	Variety SR 91
	Number	*Crates*	*Crates*	*Crates*
Very Wet............	13	125	92	129
Wet.................	10	139	104	141
Medium..............	5	115	98	148
Dry.................	4	101	87	110

Results in 1954 are quite similar to the 1953 data. However, the PMR 450 variety was not nearly as responsive. The differences are not nearly as large as they were the previous year.

On the basis of the two years' data it appears that a wet treatment, irrigating when the soil moisture tension reaches 2/3 atmospheres, would give optimum total yields. This moisture level also produced more large melons than the other treatments. The proportion of culls produced was not influenced by moisture treatment.

California

CHLORINE AIDS INFILTRATION IN SHAFTS--MAY BE "OUT" FOR BIG AREAS

Curtis E. Johnson, Bakersfield.--It has been shown that clogging of soil pores by products of microbial activity such as slimes, gums, polysaccharides, gases and microbial cells causes the infiltration rate of continuously submerged soil to decline with time. A 340-day test was run on a small (0.005 acre) metal-sided field pond to determine the effect chlorination of the water supply would have upon the infiltration rate and micro-organism population of the soil. The Hesperia sandy loam soil was continuously flooded with the exception of one period of 3 days duration. Chlorination rates of zero to 120 ppm were used.

As previously reported (quarterly report No. 4), a continuous chlorine treatment of 5 ppm did not appreciably reduce microbial activity, and infiltration rates were only slightly increased over those obtained on non-chlorinated runs on the same pond. When the chlorination rate was increased to 15 ppm, the infiltration rate was increased to approximately that of untreated water during a pretreatment test run. Chlorination was discontinued after 121 days; the infiltration rate dropped off rather sharply and the microbial population increased rapidly.

Chlorination was restarted at 25 ppm on the 209th day, and the low infiltration rate was nearly doubled following a 5-day chlorine treatment. A week after the chlorine treatment was discontinued, the rate again began a sharp decline.

A final chlorination of approximately 125 ppm was started on the 245th day. Again there was an increase in infiltration rate, followed by a leveling off. Samples of soil taken to a depth of 2 feet on the 324th day were found to contain no live microorganisms.

Whenever chlorine was applied after a period of non-chlorination, the infiltration rate increased and numbers of microorganisms in the soil declined. However, the peak infiltration rate which occurred on the 34th day was never again reached, even with the high chlorination rate.

Causes other than microbial activity may have been contributing to the decline in rate. Such causes might be (1) deterioration of soil structure due to slow solution and breakdown of substances binding aggregates together; (2) rearrangement of surface soil particles due to water movement; (3) disintegration of aggregates due to the action of the chlorine on the organic portion of the soil; (4) clogging of soil pores with particles of rust from metal pipes, the metal pond borders, dead microorganisms and their products.

Although this soil has a readily oxidizable organic matter content of slightly less than one percent, residual chlorine is reduced very rapidly as the chlorinated water moves into and through the soil. For example, the chlorine content of the soil-water extract was reduced from 120 ppm to 12 ppm after passing through one foot of soil and to 2 ppm after passing through two feet of soil. These results were obtained after chlorination at 120 ppm for 50 days plus previous chlorination at lower rates. The residual chlorine factor coupled with the possible deleterious effect of the chlorine on soil structure appears to eliminate chlorination as a method of increasing infiltration rates of large surface areas. However, chlorination of wells, shafts, and pits or ditches which contact coarse aquifer material would seem to be a practical means of preventing clogging by microbial activity.

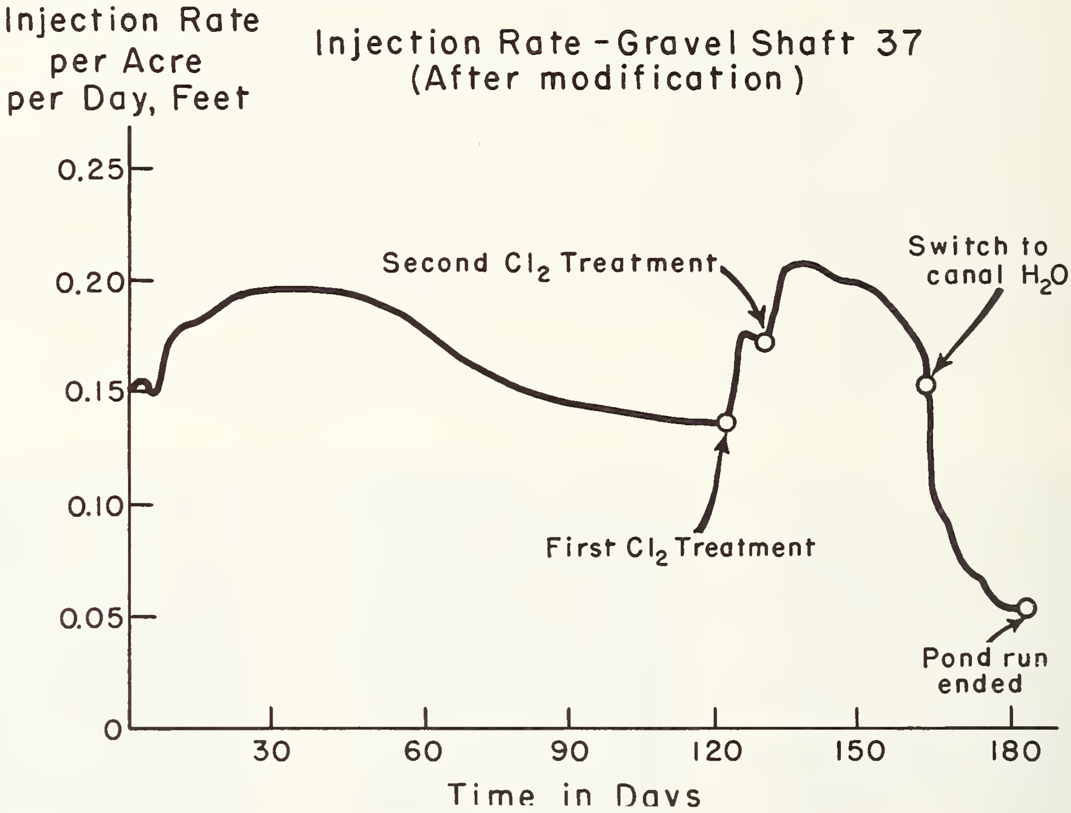
EXPERIMENTING WITH AQUIFER REPLENISHMENT

Curtis E. Johnson showing experimental sites near Bakersfield, Calif. At left, Johnson is working in one of the metal-sided "ponds" which are filled with water from tanks in background. This "pond" is divided diagonally, and piezometers have been driven into both parts. Center photo shows surface of "pond" which includes a shaft filled with coarse material. Note how crust or scum forms on surface after being covered for some time with water. One object of study is to learn how to prevent sealing of surface. On right, Johnson points to a transparent connection which enables research staff to see that chlorine is entering water line into a pond. Leonard Schiff and Eldred S. Bliss are the other members of the team at Bakersfield working on problems of replenishing aquifers by means of water spreading and injection through shafts and pits.

WATER INJECTION RATE HOLDS UP WELL IN IMPROVED SHAFT

Eldred S. Bliss, Bakersfield.--Studies on gravel-filled injection shafts reported in previous quarterly reports have been continued. Laboratory studies have been made on samples from one shaft to determine more about the nature of clogging or sealing.

Previously reported piezometer measurements showed that clogging or sealing was occurring near the interface between the shaft and the acquifer into which water was moving. An analysis showed fine material and organic matter, in part from microflora, had collected at the interface, undoubtedly accounting for part of the clogging. The effect of microbial activity in sealing up surface soils under flooding is reported separately. Injection rates on an improved test shaft are shown on the accompanying graph.



It is significant that after 120 days of continuous operation, the injection rate was still more than 70 percent of the peak rate.

Attempts were made to restore the infiltration rate to its initial peak with chlorination treatment followed by pumping out to remove clogging materials loosened by the chlorine. A first flushing with about 170 ppm of free chlorine in the injection water, continued 2-1/2 hours, was only partially successful. A second treatment, given 8 days later, consisted of injecting 20 gallons of 15,000 ppm chlorine solution (calcium hypochlorite) into the central pipe. This "slug" stood for 30 minutes and was then pumped out as before. Results as shown on the rate graph indicate this was a more beneficial treatment.

The decline in rate following this second treatment was considerably hastened by several short unavoidable interruptions in the water supply. Tests to determine more specifically the effects of intermittent supply are planned.

To determine the effect of a different water type on injection rates, the water supply was changed from well to canal water on the 164th day. Eighteen days later the run was terminated to avoid using muddy waters resulting from a storm. However, as shown by the graph, rates declined very sharply during this short period. The principal causes for this are considered to be (1) temperature differences, (2) additional short interruptions in water supply, (3) differences in total salt concentration (both waters are classed as "good" for irrigation), (4) difference in microbial flora and undissolved solid content. Some of these factors will be evaluated in a future report.

<u>California</u>

INJECTION OF WATER UNDERGROUND THROUGH PIT IS PROMISING

Leonard Schiff, Bakersfield.--An infiltration pit designed to inject water directly into an aquifer under high head was placed in operation on Nov. 15, 1955, at Minter Field near Bakersfield. This pit has side slopes of about 1-1/2 to 1, is about 9 feet deep, and cuts into a sand aquifer to a depth of 3 feet. The sand of the exposed aquifer was covered with a 6-inch layer of pea gravel to serve as a filter.

The pit maintained a fairly steady infiltration rate of 1.9 acre feet per day or 57 acre feet per day, considering only the area of exposed aquifer, which took most of the water. This rate continued until the pit was shut off at the end of 17 days. When use of the pit was started again after several days, the infiltration rate was 1.2 acre feet per day. Although still a good rate, comparing with about 0.5 acre feet per day by surface flooding, it is believed the drop was due to disturbance of the filter. The infiltration pit is now undergoing suction cleaning. After the cleaning, it will be kept in continuous operation for a longer period.

<u>California</u>

UPPER SAN JACINTO BASIN SHOWS PROMISE FOR WATER SPREADING

V. S. Aronovici, Pomona.--Previous investigations indicated that in the San Jacinto basin the upper alluvial fan of Bautista Creek and the San Jacinto River showed promise as water spreading areas. Preliminary short-term ring infiltrometer observations indicated the flood plain of Bautista Creek to be more pervious than the stream bed itself.

A 1/1,000 acre infiltrometer was installed in October 1955, and observations continued for three months. The stratified Handord coarse sand to loamy sand appears to be an excellent spreading site. As might be expected, lateral capillary flow from the infiltrometer was observed after a few weeks. A boring made 6 feet from the side of the infiltrometer struck moist soil at a depth of 2.5 feet. To check the influence of stratification when lateral flow was restricted, a small stainless steel ring 12 inches in diameter and 52 inches long was driven 40 inches into the soil. Observations were started on this unit the first week in December. Tabulated below are the observed rates of the two units.

Comparative infiltration velocities of two types of infiltrometers

Elapsed time	Infiltration per day in 1/1,000-acre infiltrometer	Infiltration per day in 12-inch ring infiltrometer
Days	*Feet*	*Feet*
1	39.2	10.4
2	31.0	7.9
4	34.5	14.0
6	31.0	12.8
8	26.0	11.9
10	26.5	11.3
15	24.2	12.1
20	20.3	13.8
30	15.2	--
40	11.5	--
50	9.5	--
75	10.0	--

Although there are only two units to compare in these first runs, it is worthy to note that the large infiltrometer rate is beginning to settle near the values observed with the deep 12-inch ring; except for the first days, the 12-inch ring shows no typical exponential change in infiltration rates which characterize the nature of the larger infiltrometer. The potentialities of this location are illustrated by the fact that during the nearly 90-day observation period a column of water 1,272 feet in depth has entered the soil from this infiltrometer or an average of 15 feet per day. These rates are probably the highest ever observed over a sustained period in southern California. Observations are being started on a second pair of units in 1956.

California

WINTER EVAPORATION AT HIGH ELEVATIONS IS ESTIMATED

Harry F. Blaney, Los Angeles.--Evaporation studies to determine monthly and annual evaporation losses from lakes (reservoirs) located at altitudes ranging from 1500 feet to 9200 feet in the Huntington Lake area near Fresno were continued during 1955 in cooperation with the Southern California Edison Company.

These reservoirs are used to store water for developing power for Los Angeles and other communities in southern California and to conserve flood waters to irrigate farms in the San Joaquin Valley.

For efficient operation of these reservoirs for power production and release of water for irrigation, it is necessary to know the monthly evaporation losses for the entire year. Since the water in the pans freezes during the winter months at high altitudes, it is not practical to measure evaporation from October to May. However, by correlating measured monthly evaporation (e) with mean monthly temperatures (t) and percent of daytime hours (p) for a five-month period, June to October, at Huntington Lake, evaporation for other months may be estimated.

This procedure is a modification of a method developed by Blaney and Morin in the Pecos River Joint Investigation in 1940-41 from evaporation records and related meteorological data at stations in New Mexico and Texas. By multiplying the mean monthly temperature (t) by the monthly percentage of daytime hours of the year (p), a monthly use factor (f) is obtained. Then it is assumed that the monthly evaporation (e) varies directly as this factor varies. Expressed mathematically, $e = kf$ = monthly evaporation in inches, where $f = \frac{txp}{100}$ and k = monthly empirical coefficient computed from measured evaporation and temperature and percent of daytime hours.

Analysis of data from stations in this area and stations at lower elevations shows that a curve may be plotted as a straight line for the period April to October and that for the winter months the curve will approximate a straight line at a different slope.

The problem of estimating evaporation from reservoirs during winter months also exists in the Rocky Mountain areas of Colorado, New Mexico, Utah, and Wyoming. A procedure similar to that described for Huntington Lake can be used for estimating evaporation during winter months when only evaporation and temperature records are available for summer months.

California

EVAPORATION INVESTIGATIONS REPORTED IN SAN FRANCISCO BAY REGION

Dean C. Muckel, Berkeley.--The first progress report on "Evaporation Investigations in the San Francisco Bay Region, California" has been prepared for our cooperator the Corps of Engineers, U.S. Army.

Evaporation records from 23 stations located throughout the bay region were available. Under the cooperative program, 8 stations were installed and are being maintained at selected locations. In all, some 2300 pan-month records are available.

Preliminary examination indicates evaporation varies much more at different locations within the rather small region than it does from year to year at any one location.

California

CONSUMPTIVE USE STUDIES CONTINUE IN SAN FRANCISCO BAY AREA

Dean C. Muckel, Berkeley.--At Joice Island evaporation station, Livingston atmometers were operated to determine the relationship between the loss of water from them, evaporation from a standard Weather Bureau-type pan, and consumptive use by tules. The first season's record is available.

Other experimenters found that the loss of water from a white atmometer in cubic centimeters multiplied by 0.0051 was equal to pan evaporation. This factor applied to the Joice Island records results in a calculated pan evaporation about 27 percent greater than the measured evaporation. For consumptive use, the difference between the loss of water by black and white atmometers is compared with the use of water by tules growing in a tank under natural environment. Conclusions can not be drawn on these short-time records.

Colorado

SALINE-ALKALI SOIL REQUIRES MORE WATER THAN CROPS USE

M. Amemiya, W. D. Kemper, C. W. Robinson, and M. M. Hastings, Grand Junction.--An experiment was initiated in 1952 near Grand Junction to determine the effects of leaching and amendments on the reclamation of a saline-alkali soil of the Billings series. Leaching was started in the summer of 1952 and completed during the following summer, at which time all plots were seeded with alfalfa. Prior to seeding, all plots received a uniform application of treble superphosphate at the rate of 400 pounds P_2O_5 per acre.

The concentration of salts and the percent of adsorbed sodium were materially reduced by the leaching treatments. This decrease was directly related to the amount of water used to leach. Leaching with 2 feet of water resulted in a satisfactory decrease in the soluble salt and exchangeable sodium percentage to a depth of 24 to 30 inches. When 6 feet of water were used to leach, the soil was reclaimed to a depth exceeding 50 inches. Gypsum application in combination with either leaching rate had little or no effect in reducing soluble salts or exchangeable sodium percentage.

Analysis of soil samples taken from the plots at the end of 1954, the first crop year, showed that below the surface 9 inches, salts and exchangeable sodium were beginning to reaccumulate. This accumulation after one crop year, though not serious, indicated that in order to sustain the benefits of soil-reclaiming measures, water in excess of crop requirements must be applied to insure the downward movement of salts and undesirable adsorbed ions. During the 1954 season, approximately 33 acre-inches per acre of water were used for irrigation. The estimated consumptive use value (Blaney-Criddle) was 35 inches. In 1955 additional water was applied for leaching purposes. Soil samples were taken from each plot again at the end of the 1955 season for analysis to determine changes, if any, in the concentration of soluble salt and exchangeable sodium percentage.

Three cuttings of hay were obtained in both 1954 and 1955. Data summarized in the accompanying table indicate that the leaching treatments have had an effect on the yield of alfalfa. With no significant differences due to the use of gypsum in combination with either leaching rate, the data have been combined to show only the effects of the different leaching rates.

Significant yield differences between the 2-foot and 6-foot leaching treatments were obtained for total yield in both 1954 and 1955. In 1954, plots initially leached with 6 feet of water yielded 5.15 tons (oven-dried) per acre, while those leached with 2 feet of water yielded 4.37 tons per acre. Corresponding values for 1955 were 5.01 and 3.81 tons per acre, respectively.

Differences between leaching treatments generally became more pronounced with each cutting and year. Apparently, differences in soil properties brought about by the different leachings were directly or indirectly affecting plant growth. Yield differences may be attributed to (1) more favorable soil moisture tension resulting from the lowered salt concentration in the profile and (2) differences in soil physical properties which affect air and water relationships.

Alfalfa yields per acre* from plots given two types of leaching treatments with and without gypsum applications, Grand Junction, Colo., 1954 and 1955

Treatment		Yield per acre*							
Water applied per acre	Gypsum applied per acre	1st cutting		2nd cutting		3rd cutting		Total of 3 cuttings	
		1954	1955	1954	1955	1954	1955	1954	1955
Feet	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
2	0	1.69	1.52	1.33	1.06	0.99	0.86	4.01	3.44
2	4	1.83	1.73	1.68	1.44	1.21	1.01	4.72	4.18
Averages		1.76	1.62	1.51	1.25	1.10	0.94	4.37	3.81
6	0	1.90	1.96	1.87	1.80	1.52	1.25	5.30	5.01
6	4	1.72	2.11	1.80	1.72	1.47	1.19	5.00	5.01
Averages		1.81	2.03	1.84	1.76	1.50	1.22	5.15	5.01

*Oven-dry basis

Virginia

HURRICANES MINIMIZE DATA IN BRACKISH WATER USE STUDY

M. H. Gallatin, Norfolk.--The increasing use of irrigation along the Eastern seaboard has necessitated development of new sources of water. Farmers have dammed up creeks and estuaries running into coastal marshes and have dug ponds and channels to impound surface and subsurface waters. Consequently, water with high salt content is often drawn on and used for irrigation, usually being mixed in with some fresh water supplies also. Some instances of severe crop damage have been attributed to use of water too high in salts.

A study was initiated by ARS in cooperation with the Virginia Truck Experiment Station at Norfolk early in 1955 to determine how to best utilize some of these brackish water sources for irrigation of vegetables. This followed previous studies by the truck station on effect of salt content in the soil on seed germination. The project does not attempt to duplicate the work done at the regional salinity laboratory but seeks to adapt those and other findings to the Eastern seaboard conditions.

The first season's work has been preliminary in nature. Two concentrations of salt (1000 ppm and 2000 ppm) were used for both surface and overhead applications. A lower concentration (500 ppm) was also used for overhead and a higher (4000 ppm) for surface. The commonly used rate of water application (1 inch) was compared with

a 2-inch rate. Applications were scheduled when soil moisture tension reached either 0.5 or 4.0 atmospheres. This season only two applications were made to the 4.0 atm series and one to the others. Two hurricanes minimized the water requirement and thereby probably minimized salt damage.

There did not appear to be any consistant yield reduction except with the 4000 ppm surface application of amounts less than 2 inches per application. There was however, visible injury to leaves with 1000 ppm as overhead application and 2000 ppm as surface application.

This season's work started with soils low in salt content. Next summer's work will continue some treatments on these same plots as well as on an additional area. Tests will be made to determine whether all the salt was leached out of the soil over the winter season.

New Jersey

IRRIGATION AIDS TRUCK CROPS FIRST YEAR OF LONG STUDY

G. D. Brill, New Brunswick.--A new long-term study involving management of truck crops under different levels of irrigation was initiated in New Jersey in the spring of 1955.

The study consists of 81 field plots located on a Collington sandy loam. Three levels of irrigation are combined with three levels of soil management and four primary vegetable crops. Irrigation levels consist of the following: (1) No irrigation, (2) irrigate to field capacity at low tension (approximately 1/4 to 1/3 available moisture depletion), and (3) irrigate when higher tension is reached (2/3 to 3/4 available moisture depletion). Soil management practices include continuous cropping with winter cash crops, continuous cropping with good winter cover crops, and a rotation with sod one year in three. Primary crops are cabbage, beets, muskmelons, and sweet corn. Spinach and turnips are grown in the fall and winter and generally do not require irrigation. The crops are fertilized in accordance with experiment station recommendations based on periodic soil tests.

First season's results, summarized in the table show that irrigation substantially increased the yields of all three crops tested over the non-irrigated. Only with sweet corn, however, did the more frequent irrigations increase the yields. Rainfall during the period April through July was 6.62 inches. This was 10.1 inches less than normal.

In addition to yields, depth of rooting and consumptive use of water will be determined. As the experiment progresses, the management practices will be evaluated.

Effect of irrigation on yields of truck crops

Crop	Yields per acre		
	Without irrigation	With delayed irrigation[1]	With frequent irrigation[2]
	Tons	*Tons*	*Tons*
Cabbage....................	14.8	20.1	19.9
Muskmelons.................	11.9	17.0	17.6
Sweet corn.................	2.11	3.60	4.21

[1] Irrigated whenever about 2/3 of the available moisture in the root zone was depleted.
[2] Irrigated whenever about 1/3 of the available moisture in the root zone was depleted.

INFILTROMETERS WITH MULTIPLE-POINT GAGES LOOK PROMISING

C. S. Slater, Beltsville.--A rapid, low-cost method of infiltration measurement for use in determining water intake rates of soils to be sprinkler irrigated is badly needed. To meet this need, a single-ring infiltrometer has been adapted and improved. The technique is now undergoing test and appears to offer promise.

The infiltrometer, shown in Figure I, consists of a single ring, 4-1/2 inches in diameter, 4-1/2 inches long, and a point gage. The point gage attaches to a bar that rests across the top of the ring. Its position relative to the soil surface is adjustable. The points on the gage are spaced so that a drop in water level can be measured accurately to tenths of an inch and estimated to closer readings.

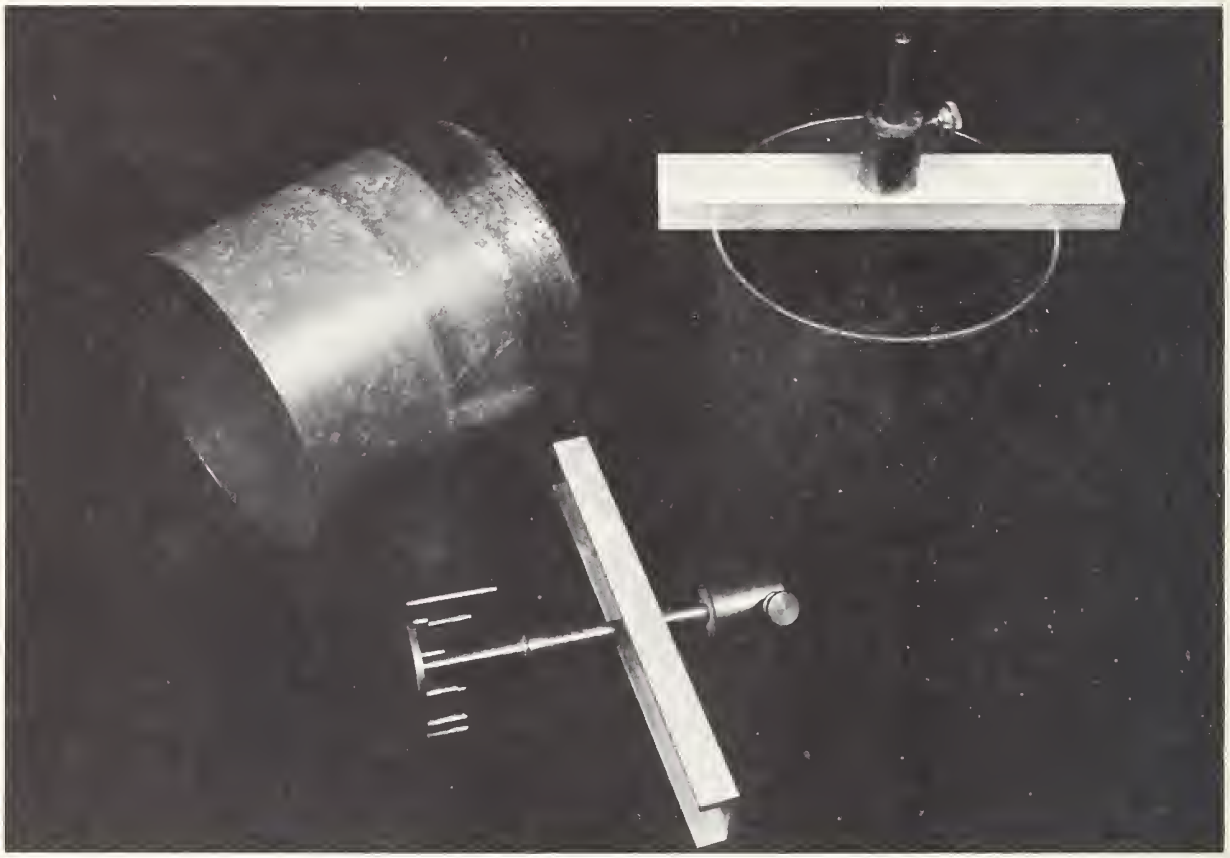


Figure 1.--Single-ring infiltrometer equipped with a multiple-point gage.

Twelve to 15 of the infiltrometers are distributed over the area to be tested, driven about 2 inches into the soil. This leaves about 2 inches exposed.

The multiple-point gage for each ring is adjusted so that the point plate just clears the soil surface. The gage is then removed temporarily. About an inch of water (250-300 cc), is poured into each ring and stirred with a rubber pestle until the surface is puddled, in the case of cultivated soils. This may take 30 seconds. Each ring is treated in sequence, and 15 minutes are allowed to elapse to allow some swelling to take place. If a ring runs dry, the process is repeated. Then the gages are set in place, water is added to the highest point on the gage, time is recorded and the rate of infiltration noted with respect to the various points on the gage. Infiltration is allowed to proceed until

an inch of water is lost from the ring, or in the case of slow infiltration, until 30 minutes have elapsed.

This technique is believed to offer certain advantages over the usual single-ring procedure. The use of the multiple-point gages speeds up the procedures in that it substitutes for a supply cylinder and constant level hoop-up. Puddling the soil surface eliminates adventitious channels which often distort infiltration measurements. Furthermore, infiltration is best represented by a time-intake curve which can be obtained easily by reading the point gage. Such time-intake curves are essential for irrigation since the rates measured after infiltration becomes relatively constant most closely parallel the rates at which irrigation water can be applied.

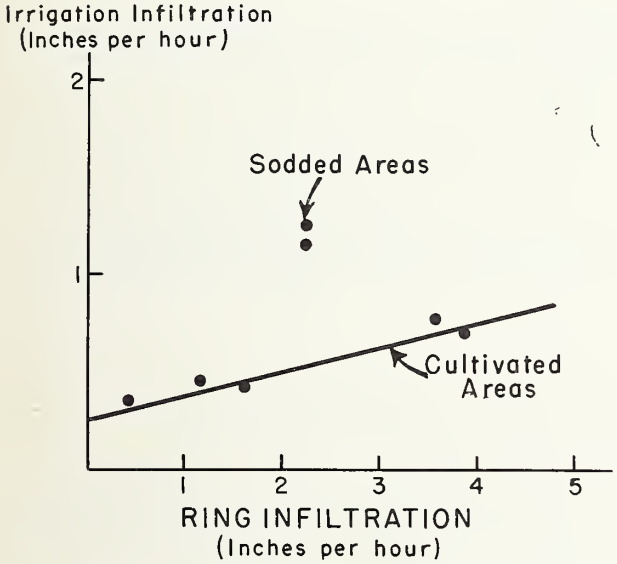


Figure 2. --Relation of infiltration in the single-ring infiltrometer to infiltration under sprinkler-type water application. One point for an irrigation infiltration of 2. 8 inches and a ring infiltration of 13. 9 inches per hour on cultivated soil is not shown.

The results of the limited number of comparisons conducted to date are shown graphically in Figure 2. Each point on the graph represent the median of 15 ring measurements plotted against a sprinkler irrigation or type F A infiltrometer measurement. The sprinkler irrigation measurements represent the stable rate portion of the infiltration curve.

The results look favorable in view of the wide deviations in infiltration rates that can occur. All but two points fall close to a line of about 5 to 1 slope. The two exceptions are measurements made on permanent sod, the rest are measurements made on cultivated land. The tentative conclusion is drawn that on cultivated land the sprinkler irrigation application rate should be about 1/4 to 1/5 of the rate obtained with rings. More data are needed to substantiate the conclusion and to clear the status of relative infiltrations on sod land.

DRAINAGE

California

REPORT INDICATES FEASIBILITY OF DRAINAGE IN TULARE LAKE SCD

Leonard Schiff, Bakersfield. --A report entitled, "Progress Report on Drainage Investigations in the Tulare Lake Soil Conservation District, Kings County, California," was presented on January 4, 1956, to the Board of Directors, Tulare Lake SCD, and other landholders in the Tulare Lake basin area by David R. Brooks of the Soil Conservation Service and Leonard Schiff. Some conclusions of that report:

(1) The saline-alkaline soil problem in the Tulare Lake Soil Conservation District is due to a shallow water table caused by tight soil, which restricts the downward movement of water. These soils are stratified and interlaced with lenses of sand which carry water laterally from the waterways and from the northwestern part of the area.

(2) Data in this report indicate that the problem is caused largely by soil conditions and land use practices within the District.

(3) There is a mound of water in the District whose ridge of maximum elevation bisects the District from north to south. The mound declines rapidly to the east. This fact dispels the theory that seepage enters the District from the east as the topography might suggest.

(4) The mound of water declines gradually to the west due to water movement into the sand beneath a clay barrier.

(5) The elevation of the mound is sustained by water use practices such as pre-planting irrigation, soil flushing, and flooding of fields for killing weeds and for the incorporation of gypsum with soil.

(6) Consideration can be given to lining or sealing waterways in sandy areas and to the use of interceptor drain ditches. Tile drains have a place in the District, as do shallow drainage wells. An investigation along such lines is recommended.

(7) Location of crops and the use of cropping systems based on water requirements and elevations of the shallow water table should be given careful consideration.

(8) A drainage disposal system is recommended. It should be independent of waterways and canals supplying irrigation water. Until water can be disposed of in a master drain for the valley, high water table conditions will become worse.

California

EXCESS PRECIPITATION AGGRAVATES HIGH WATER TABLE CONDITIONS

Dean C. Muckel, Berkeley.--An analysis of precipitation records in the Contra Costa Soil Conservation District was made to determine how much water falling on the watershed is in excess of the evaporation-transpiration requirements. Fall soil moisture deficiencies used in the analysis were available from previous studies.

There appears to be a straight line relationship between excess water and precipitation for this area and type of storm that occurs. The points fall generally on a line $W = \frac{P}{1.4} - 10$ where W is excess water and P is annual precipitation.

No attempt was made to divide the excess water into "surface runoff" and "deep penetration", nor is this thought necessary. In most years the water from both sources accumulates in the low-lying farm areas and aggravates high water table condition, the correction of which is an objective of this study.

Louisiana

GRADING DELTA LAND TAKES 6 MACHINE HOURS

I. L. Saveson, Baton Rouge.--Farmers and agricultural operation agencies are concerned with the costs and methods of grading delta land to facilitate drainage and irrigation. A limited amount of information was obtained in 1955 from a Dubbs silt loam area at Newellton, La., which was graded with a Cat-7 tractor and Cat-60 scraper and a D-6 tractor with 50-foot land leveler.

The rows and implement scars were removed to facilitate a survey. Grades and yardage were then computed from a grid-type survey with levels on 100-foot stations. Cuts and fills were marked on the grid stakes and the area worked in lanes during the forming operation, leaving the stakes in the cut areas on small islands for reference points to be removed by the smoothing operation. The forming operation was done with D-7 Cat tractor and scraper. After forming, the areas were finished and smoothed with the land leveler. To expedite the work, the scraper was also used to smooth the

area ahead of the land leveler. Following is the grading information which was obtained from the area:

Equipment and machine time required to grade undulating Dubbs silt loam to a 1% slope

Operation	Equipment	Hours per acre
Smoothing to facilitate surveying and staking the field..	Tractor and Scraper D-6 tractor and land leveler	.93
Forming the land..................	D-7 Cat tractor and scraper	3.07
Smoothing and finishing...........	D-7 Cat and scraper D-6 Cat and land leveler	2.00
	Total	6.00

Average haul distance - 400 ft.

Cubic yards of earth moved per acre - 426

Earth moved per hour by scraper and D-7 Cat - 136 cubic yards

Maximum cut - .9 foot

Machine hiring costs vary from one section of the area to the other, ranging from $8 to $15 per hour. At $10 per hour, this work would cost $60 per acre.

EROSION AND RUNOFF CONTROL

Kansas

WIND ERODES SOIL BY SORTING AND DISINTEGRATING FRACTIONS

W. S. Chepil, Manhattan.--A series of studies, initiated in 1949, on the intricate phenomenon of sorting and rate of removal of various soil constituents by the wind has been completed. Results of the first of these studies are reported herein.

The wind erosion process was characterized by 2 major phases: The sorting of various soil constituents and the disintegration of aggregates to primary particles by the abrasive action of wind-eroded grains.

In the first phase, the wind-eroded soil materials tended to be sorted out into several distinct grades, some of which were as follows: (1) the nonerodible fractions remaining in their original locations in the field, (2) the lag materials moving slowly in surface creep and deposited primarily in surface depressions throughout the field, (3) the grains moving rapidly in saltation and deposited usually in drifts or mounds throughout the affected area, (4) the transitional materials carried partly in saltation and partly in suspension producing rather uniform deposits to the lee of the drifts and (5) the dust particles kicked up by the saltating grains to form dust clouds usually carried great distances from their source. Removal of dust particles in suspension, although variable in magnitude, was appreciable for each soil investigated. On the average, almost 60 percent of the total dust content (particles of a diameter smaller than 0.1 mm.) in that portion of the soil moved by a single windstorm was removed (deflated) great distances through the air.

In the second phase of the wind erosion process, both the transported and the stationary soil fractions were disintegrated to smaller fractions. The impacts of grains in saltation appeared to cause the greatest degree of disintegration. The secondary aggregates or clods tended to break down into primary (water-stable) aggregates most

of which were readily transported by the wind. These primary aggregates in turn tended to break down into individual mechanical fractions--sand, silt, and clay.

Silt was more readily removed from soil than either sand or clay, except from soil classes such as sand and loamy sand already having a relatively low ratio of silt to clay. The silt particles exhibited little cohesion and were, therefore, readily separated by disintegrating forces of wind erosion. Moreover, they were small enough to be readily lifted and removed high into the atmosphere. The clay particles, on the other hand, exhibited great cohesive property and, therefore, tended to form stable aggregates too large to be lifted into the atmosphere.

The sorting process of wind erosion has caused a profound change in the mechanical composition of some soils and little change in others, depending on their physical characteristics. On fine alluvial and loessial soils composed mainly of silt and some fine sand and clay, wind erosion did not appreciably change the elementary mechanical composition of the residual soils. Here the wind had little tendency to remove one mechanical fraction faster than any other. On loamy and sandy soils, on the other hand, the wind tended to remove the silt and clay and leave the sand behind. The accumulations of sand reduced the soil productivity and added further to the hazard of wind erosion and to the problem of how to hold the remaining soil.

Oklahoma

BREAKING PLOW PAN TENDS TO REDUCE RUNOFF FIRST TWO YEARS

Harley A. Daniels, Guthrie.--Studies were initiated in 1952 on the breaking of the plow pan in cultivated soils at the Wheatland Conservation Experiment Station, Cherokee. Where the plow pan was disrupted, runoff from 3 storms causing water loss in 1953 was less from both the chiseled and deep-plowed plots than from the untreated plots. The second year after treatment (1954), runoff from 7 storms was still substantially less on the plowed land than on either the chiseled or untreated plots. But, in 1955, the third season after tillage treatments, runoff losses from 10 storms were practically the same from the chiseled, deep plowed, and untreated plots. (See accompanying data.)

Rainfall was abnormally low during each of the 3 cropping seasons. The 1953 season was the driest recorded at this station. The summer, fall, and winter of 1954 and early spring of 1955 were also so dry that the wheat failed. There were only 6.09 inches of precipitation from July 1, 1954, to May 1, 1955. But 13.85 inches of rain came in May and June of 1955. It fell on bare land (the wheat had failed) and runoff was rather high. However, runoff losses were extremely low during 1953 and 1954. In fact, there were not as many storms causing runoff during this 3 year period of drought as during some of the wet seasons. For example, there were 31 storms causing runoff from a total of 42.10 inches of rain in 1949, while there was a total of only 20 storms causing runoff from 57.25 inches of rain during the 3-year period, July 1, 1952, to June 30, 1955.

The deep plowing in the summer of 1952 destroyed most of the straw on the surface. The surface soil was too dry for moldboard plowing during the summer of 1953 and 1954; consequently, the one-way disk was used for the first tillage operation. Although the 3-year period was abnormally dry, a fair crop of wheat was produced in 1954; however, it was a complete failure in 1955.

Effect of disrupting plow pan on moisture conservation and wheat production at the Wheatland Conservation Experiment Station, Cherokee, Okla.

Cropping season and treatment[1]	Rainfall	Runoff as percent of rainfall	Wheat yield per acre[2]	Straw on surface per acre
	Inches	*Percent*	*Bushels*	*Pounds*
1952-1953				
Chiseled	15.23	0.5	11.3	2,322
Deep plowed	15.28	0.3	13.5	84
Untreated	15.21	0.7	11.9	2,332
1953-1954				
Chiseled	22.07	8.4	15.6	1,704
Deep plowed	21.74	4.0	16.7	1,010
Untreated	21.94	9.6	17.1	1,784
1954-1955				
Chiseled	20.01	15.5	--	2,440
Deep plowed	19.89	13.9	--	2,003
Untreated	20.01	14.1	--	2,070

[1] The chiseling and deep plowing treatments were made in July of 1952 at a depth of about 12 inches.
[2] The wheat crop was a complete failure in 1955.

Indiana

RAINFALL SIMULATOR BEING DEVELOPED FOR EROSION STUDIES

L. Donald Meyer and Donald L. McCune, Lafayette.--Use of artificial rainfall to acquire runoff and erosion data more rapidly and economically than can be obtained by waiting for a natural sequence of rainfall is being investigated.

Development is progressing on an apparatus for use on full sized plots that will closely simulate the input energy of rainfall at several selected intensities. This rainfall simulator will be developed in sections that may be assembled to cover plots and small watersheds of various shapes and sizes. With this apparatus, data may be obtained at desired times and conditons without reliance on natural rainfall. Studies will be designed to evaluate qualitatively the various soil, water, topographic, crop, and management factors that affect runoff, erosion, and infiltration under controlled field conditions.

Many types of irrigation equipment have been tested for possible use with this apparatus. In general, they have failed to simulate closely enough the combination of drop size, velocity of fall, distribution, and intensity of natural rainfall. At present, various spray nozzles are being tested for drop size, velocity, and distribution. Certain nozzles are giving particularly promising results when directed downward. In this position, improved characteristics result from the initial velocity imparted to the drops by pressure and from decreased wind interference. Overlap patterns and apparatus design for use of these nozzles are also being studied so that good distribution and satisfactory methods of application may be attained.

Experimental models of this rainfall simulator will soon be designed, and it is planned to have at least one model constructed for field testing by the summer of 1956.

CROPPING SHOULD BE ADAPTED TO SLOPE, LONG-TIME DATA SHOW

A. P. Barnett, Watkinsville.--Runoff plot studies were begun at the Southern Piedmont Conservation Experiment Station at Watkinsville in 1938 and 1939. A total of 42 plots were installed on Class IIe, IIIe, and IVe land with Cecil soils having slopes of 3, 7, and 11 percent, respectively. Slope lengths simulated approximate terrace spacings on the various land classes.

The cropping systems studied were designed to give varying degrees of protection on the 3 land classes. Cotton grown continuously was the check treatment with minimum protection. All crops in a rotation were on the land each year. Treatments were duplicated whenever possible.

The following conclusions can be drawn, from data from Class IIIe land plots of 7 percent slope where cotton was grown continuously for 13 years, 1940-52:

1. Average annual rainfall was normal during the 13-year period studied, as compared to the 70-year average.

2. Erosion varied widely from year to year; the maximum annual erosion was 53 tons per acre in 1943, and the minimum, 5 tons per acre, occurred in 1952.

3. Severe erosion-producing storms occurred during all months but most frequently during the spring and summer.

4. Terraces with contour cultivation did not afford adequate erosion control on sloping rowcrop lands but needed to be augmented by other practices.

Table 1 shows that excessive storms caused most of the erosion. The amount of rainfall and runoff had little bearing on the amount of erosion during any season. However, there existed a close relationship between the number of excessive storms each season and the corresponding erosion produced. A study of the 30-year tables in USDA Miscellaneous Publication No. 204, "Rainfall Intensity - Frequency Data", showed that on the basis of the distribution and number of excessive storms, the Watkinsville data are generally applicable to the entire Southeastern United States.

Table 1.--Average seasonal distribution of rainfall, runoff, number of excessive storms[1], and erosion; Class IIIe land of 7-percent slope in cotton continuously, 1940-52, Watkinsville, Ga.

Season[2]	Rainfall		Runoff		Excessive storms[1]		Erosion	
	Amount	Portion of annual total	Amount	Portion of annual total	Average number	Portion of annual total	Amount per acre	Portion of annual total
	Inches	*Percent*	*Inches*	*Percent*	*Number*	*Percent*	*Tons*	*Percent*
Winter...........	14.1	28.3	2.8	26.4	.7	6.2	3.3	16.9
Spring...........	14.0	28.1	2.7	25.5	2.5	22.1	5.2	26.5
Summer...........	12.6	25.3	3.0	28.3	6.4	56.6	9.8	50.0
Fall.............	9.1	18.3	2.1	19.8	1.7	15.1	1.3	6.6
Annual...........	49.8	100.0	10.6	100.0	11.3	100.0	19.6	100.0

[1] Excessive storms as defined by Yarnell in U.S. Dept. Agr. Misc. Pub. 204.
[2] Winter: Dec.-Feb., Spring: March-May, Summer: June-Aug., Fall: Sept.-Nov.

The distribution of excessive storms and erosion in the different seasons clearly showed that the principal need for protection to the land existed during the summer growing season of row crops. Rotations must be designed to assure that maximum protection is provided during the row crop period.

Watkinsville studies show maximum resistance to erosion during the row crop period was provided by winter and summer legumes grown ahead of the row crops in the different rotations.

Table 2 presents a summary of selected data for 4 of these rotations during the 13-year period 1940-52. The following general conclusions may be drawn from these data:

(1) Continuous cotton culture alone does not offer adequate protection to the land on any of the land classes studied. Adequate protection has been arbitrarily defined as a treatment or crop rotation whose average annual erosion was 3 tons per acre or less. The similarity in the runoff and erosion losses from cotton continuously on Class IIIe and IVe land may be attributed to 2 factors: First, the slope length of the Class IVe land plot was half that of the Class IIIe land plots; and second, the Cecil sandy clay subsoil seems to have some greater resistance to erosion than the more sandy soils.

(2) Both summer and winter legumes protected the land from damaging erosion during the time they were on the land.

(3) Where a row crop followed a legume, runoff and erosion during the row crop year were much less than from continuous row crops.

(4) Continuous row crops with winter and summer legumes, as shown by rotation 10 in Table 2, afforded adequate runoff and erosion control on Class IIe land; but this same treatment when planted on Class IIIe land failed to offer adequate runoff or erosion control.

(5) A 2-year rotation of one year of cover crop and one year of row crop fell somewhat short of good control on Class IIIe land, as illustrated by rotation 26.

(6) Rotation number 14--two years of annual lespedeza and one of cotton--provided adequate control of runoff and erosion on Class IIIe land. When placed on Class IVe land, however, this rotation failed to offer adequate protection, indicating a need there for a "stronger base" rotation.

(7) A "stronger base" rotation was found in the 3-year kudzu rotation, Number 19. Enough kudzu survived in the corn rows to provide some soil protection, in addition to the after-effects of the normal heavy kudzu cover crop during the row crop season. The kudzu then grew the second and third year as the cover crop phase of the rotation. This rotation did a remarkable job of controlling runoff and erosion on a slope length of 70 feet, twice that of Rotations 1 and 14 on Class IVe land.

These results show a definite need for adapting cropping treatments carefully to suit the slopes on which the crops are grown.

Table 2.--Runoff and erosion from plots of Class IIe, IIIe, and IVe land with various rotations, Watkinsville, Ga., 1940-52

Rotation number	Crops	Class IIe land (3% slope; Cecil loamy sand)*					Class IIIe land (7% slope; Cecil sandy loam)**					Class IVe land (11% slope; Cecil sandy clay loam)***				
		Years of crop	Rainfall	Runoff		Erosion per acre	Years of crop	Rainfall	Runoff		Erosion per acre	Years of crop	Rainfall	Runoff		Erosion per acre
		Number	*Inches*	*Inches*	*Per cent*	*Tons*	*Number*	*Inches*	*Inches*	*Per cent*	*Tons*	*Number*	*Inches*	*Inches*	*Per cent*	*Tons*
1	Cotton continuously	13	49.2	7.6	15.4	3.4	13	49.8	10.6	21.3	19.6	13	48.6	10.9	22.4	19.2
10	Corn--crotalaria	10	49.9	4.2	8.4	2.1	9	49.8	6.1	12.2	4.8					
	Cotton - vetch	"	"	4.6	9.2	1.9	"	"	7.6	15.3	6.4					
	Rotation average	"	"	4.4	8.8	2.0	"	"	6.8	13.7	5.6					
26	Oats-kobe lespedeza(1)						9	48.3	6.0	12.4	2.8					
	Cotton-oats						"	48.2	3.8	7.9	4.7					
	Rotation average						"	48.2	4.9	10.2	3.8					
14	Oats-kobe lespedeza(1)						12	50.0	7.1	14.2	2.9	10	47.4	9.4	19.8	7.0
	Vol. kobe lespedeza(2)						11	49.8	1.9	3.8	.2	"	"	4.4	9.3	.9
	Cotton-oats(3)						9	51.0	4.9	9.6	4.3	"	"	6.5	13.7	6.1
	Rotation average						10	50.3	4.6	9.2	2.5	"	"	6.8	14.3	4.7
19	Oats-1st. kudzu(4)											7	49.5	3.5	7.1	.7
	2nd kudzu(5)											9	49.7	2.1	4.2	.1
	Corn-kudzu-oats											8	49.6	3.1	6.2	.8
	Rotation average											8	49.6	2.9	5.8	.5

(1) harvested for seed (2) harvested for seed 41-48, then hay 49-52 (3) On class IVe land corn was the row crop 43-47 (4) 1st kudzu recovery after corn (5) harvested for hay

*Slope length, 105 feet; plot 1/20 acre.
**Slope length, 70 feet; plot 1/30 acre.
***Plots with Rotation 14: Slope length, 35 feet; plot 1/60 acre. Plots with Rotation 19: Slope length 70 feet; plot 1/30 acre.

Mississippi

SOD-SEEDING EFFECTS ON EROSION, RUNOFF TO BE STUDIED

C. K. Mutchler, ARS, and T. N. Jones, Miss. Agr. Exp. Station, State College.--A method of seeding in sod for winter grazing has been developed at the Mississippi Agricultural Experiment Station. This method allows use of permanent pasture land for winter grazing by seeding to cereals or winter-hardy grasses in the fall. Seed is sown in rows 16 to 20 inches apart using a slit-type opener leaving the sod only slightly disturbed. The practice of sod-seeding has been widely accepted by farmers in Mississippi and adjoining states.

Several companies are producing sod-seeding machines. The photo shows a two-row machine developed for small farmers. The applicators of a conventional sod-seeder are attached to the front gangs of a standard cultivator with planter and fertilizer attachment.

A project has been initiated to determine the effects of sod-seeding on erosion and runoff from permanent pasture lands. Runoff and soil losses are being measured with Coshocton-type runoff samplers.

New York

PREVIOUS EROSION AFFECTS YIELD AFTER 9 YEARS OF GOOD TREATMENT

George R. Free, Ithaca.--The effects of previous erosion on subsequent productivity under good management has been measured at The Arnot, New York.

The plots were located on Bath flaggy silt loam, 20 percent slope, Capability Class III. Differential treatments resulting in different erosion losses were applied to these plots in the period 1935 to 1945. Since that period all plots have received the same treatment.

Corn was grown on these plots in 1946 and 1947, a fertilized grass-legume sod in 1948 and 1949, corn in 1950, fertilized grass-legume mixture in 1951, 1952 and 1953, and corn in 1954. All corn crops were fertilized with 1000 pounds per acre of 10-10-10. There was no harvest or removal of material from the grass-legume sods. The corn yields and the trends in organic matter content and aggregate stability are shown in the table.

The severely eroded plots of Group I yielded only 35 percent as much corn as the uneroded plots of Group IV in 1946, but with treatments which increased the organic matter content and aggregate stability the Group I plots yielded 87 percent as much corn as the uneroded plots in 1954.

Plot group*	Soil lost per acre		Organic matter in 0-6" depth of soil		Aggregate stability		Corn yields per acre			
	1935-1945	1946-1947	1946	1954	1946	1954	1946	1947	1950	1954
	Tons	*Tons*	*Percent*	*Percent*	*Percent*	*Percent*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
I.............	73.5	2.3	3.0	3.4	65.8	80.5	28	26	46	72
II............	28.2	1.7	3.4	3.8	75.1	84.0	42	50	49	76
III...........	14.0	0.9	3.9	4.2	80.9	84.0	50	56	53	84
IV............	1.3	0.2	4.4	4.7	83.6	86.9	80	75	62	83

*Grouped according to 1935-45 treatments.

SOIL FERTILITY

Arizona

NITROGEN FERTILIZER INCREASES EFFICIENCY OF WATER USE BY BARLEY

C. O. Stanberry and M. Lowrey, Yuma.--Substantial acreages of coarse-textured soils are farmed under irrigation in the Western States. In parts of the Southwest, low soil-moisture-holding capacity, excessive summer temperatures with a high consumptive use of water by plants, and the inherent low soil-fertility level interpose serious obstacles to success by the farmer. Selection and planting of adapted crops and subsequent use of efficient soil management practices are essential if modest success is to result from the use of these soils.

Alfalfa for hay, seed, and pasture is one of the most successful crops grown in deep sandy soils. Thinning stands, however, and infestation of sandburrs and summer grasses or other weeds periodically require reseeding or rotating alfalfa with another crop. Barley fits well into such a system and supplies feed complementary to alfalfa hay. It is possible to plow out a thinning stand of alfalfa in late summer or early fall and plant barley in fall or early winter. After barley harvest the following summer, fallowing may be practiced to destroy summer weeds before reseeding alfalfa or another crop in the fall. Summer weeds may also be controlled by growing a cultivated crop such as sorghum, or by producing a dense vigorous growth of sudan grass which will shade out the weeds.

Alfalfa is the crop most widely grown on the Superstition sand of the Yuma Mesa. Small acreages of barley have been grown, but most yields do not exceed 60 bushels. Tillering or number of heads per plant, and size of individual heads affect barley yields importantly. Factors affecting head size and tillering locally are not known, but both supplemental nitrogen and adequate moisture are important in increasing barley yields.

In an experiment in 1954 Arivat barley was planted. Different rates of nitrogen fertilizer and irrigation frequencies were applied. Ammonium sulfate and calcium nitrate were compared at equivalent rates of nitrogen. Maximum yields with supplemental N were about 60 bushels, but one nitrogen source was no better than the other.

In 1955, California Mariout barley was planted and the experiment repeated. Yields varied from 7 to 100 bushels, the ammonium sulfate proving superior to the calcium nitrate, possibly because it leached less.

During 1956, the experiment is again being repeated on both Arivat and Mariout varieties for investigation of differential irrigation frequency, nitrogen rate, and nitrogen source. The two varieties are being compared in a single year to determine if seasonal variation may have accounted for differences in response to ammonium sulfate and calcium nitrate and in considerably greater yields during 1955.

Soil samples taken throughout both growing seasons indicate that the barley crop secured about 70 percent of its total moisture requirement from the top 2 feet of soil. Figure 1 shows the zone of moisture extraction and the mean relative amounts of water utilized at each depth to 48 inches.

The effect of 5 levels of nitrogen fertilizer varying from 0 to 240 pounds per acre on yield, total water used, and the efficiency of this water use is demonstrated in the three curves in Figure 2. Somewhat more water is utilized by the crop at high rates of nitrogen than at low rates but without appreciable increase in yield. Without fertilization, barley yields are so low that water use is relatively inefficient. Supplemental nitrogen increased yields from 80 to 100 percent without proportionately increasing the total amount of water used.

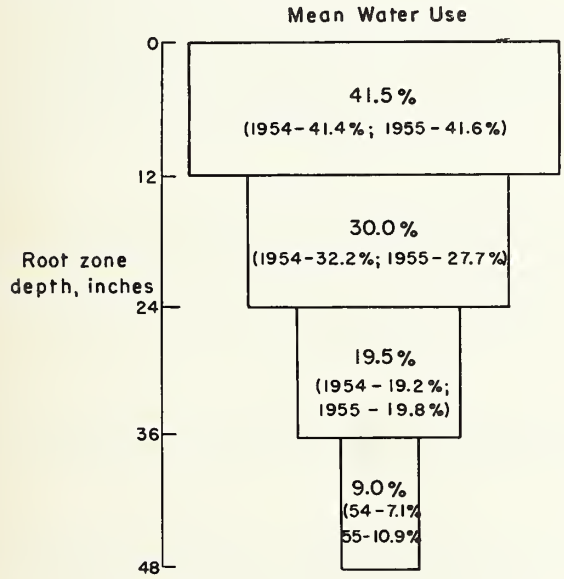


Figure 1. --Mean zone of moisture extraction by barley for 1954 and 1955 (Arivat and Mariout, respectively) and relative amounts of water utilized at each depth to 48 inches. Total water use was different for the three moisture levels (wet, medium, and dry) but the extraction patterns were so similar that only mean values are plotted.

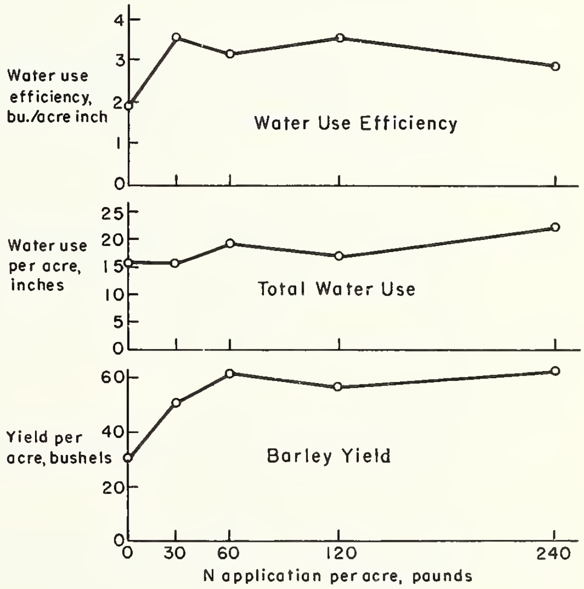


Figure 2. --Effect of nitrogen fertilizer rate upon barley yield, total water used, and the water-use efficiency in yield per unit of water (1954 data).

One of the most important problems in much of the irrigated West is that of getting maximum economic production from limited water supplies. Good soil management practices, such as the use of adequate nitrogen fertilizer, are essential in making the most efficient use of the water available.

Oregon

WIDE VARIATIONS REPORTED IN WHEAT YIELD RESPONSES TO FERTILIZERS

Albert S. Hunter, Corvallis. --The analyses of variance and summarization of wheat yield responses to variations in fertilizer have been completed for the 48 experiments on winter wheat and one experiment on spring wheat that were conducted in the Columbia Basin Counties of Oregon in 1954-55. A preliminary note on this work was presented in a previous progress report.

C. J. Gerard, Bob P. Chesney, H. Marr Waddoups, H. E. Cushman, and County Agents of Umatilla, Morrow, Gilliam, Sherman, and Wasco Counties participated actively in these experiments. Analyses of variance of the yield data were made by the O.S.C. Statistical Service, Lyle A. Calvin in charge.

Summaries of the yield and test weight data have been prepared. Coefficients of variation, soil depths, soil series and types, dates of fall and spring fertilizer applications, and wheat varieties are of record with the data grouped according to counties.

Some of the more significant results are listed as follows:

1. There were 37 and 35 farms, respectively, on which some rates of fall-applied or spring-applied nitrogen had significant effects upon wheat yields in comparison with no nitrogen. On 11 and 14 farms, respectively, no rate of fall-applied or spring-applied N demonstrated significant effects upon yields.

2. Of the 37 farms where significant effects were produced from fall-applied nitrogen, there were 24 where yields were increased by some rate of N, and 13 where all rates of applied nitrogen decreased yields. On the 24 farms where yield increases were obtained, the maximum yields that can be demonstrated (highest yield that was not exceeded by any other yield by an amount as great as the least significant difference between means) were produced by 20 pounds of N per acre on 7 farms, by 30 pounds on one farm, by 40 pounds on 9 farms, by 60 pounds on 7 farms, and by 80 pounds on one farm. There were 11 farms where fall-applied nitrogen produced no significant effects on yield.

3. There were 35 farms where spring-applied nitrogen produced significant effects on yields. On 26 farms yield increases were produced; on 9 farms yield decreases resulted from all rates of applied nitrogen. Maximum demonstrable yields were obtained from 20 pounds of N per acre on 5 farms, by 30 pounds on one farm, by 40 pounds on 9 farms, by 60 pounds on 9 farms, and by 80 pounds on 3 farms. On 13 farms no significant effects of nitrogen on yield were produced.

4. There were 12 farms on which one or more rates of fall-applied nitrogen gave significant yield increases, followed by significant yield decreases as the rate of N increased. In the case of spring-applied nitrogen, this phenomenon was observed on 6 farms.

5. The analyses of variance indicate that there were 5 farms on which fall-applied nitrogen produced significantly higher yields of wheat than spring-applied nitrogen. There were 9 farms on which the reverse was true. On 29 farms there was no significant difference in effects of fall-applied and spring-applied nitrogen.

6. In cases where spring-applied nitrogen produced significantly greater yield than fall-applied nitrogen, it was usually because the yield depression produced by spring-applied was less than that resulting from fall-applied nitrogen. In all but 2 of these cases, yield depressions resulted from higher rates of nitrogen, applied in either fall or spring.

7. Analyses of variance indicate that phosphorus increased yields significantly on only 3 farms.

8. There appears to have been no yield response to the minor elements, boron, copper, manganese, and zinc.

9. There was a tendency for test weight values to decrease with increasing nitrogen rate. This tendency was most pronounced where increasing nitrogen decreased yields.

10. With 1953-54 data determination of the correlations between soil nitrogen, soil moisture plus rainfall, and yield responses to nitrogen fertilizers is in progress but not yet completed. The data for 1954-55 are being summarized.

11. Work is in progress on an Oregon Agricultural Experiment Station Miscellaneous Publication on the results of 2 years of fertilizer experiments on wheat in the Columbia Basin counties.

Oregon

PHOSPHORUS AND POTASSIUM DECREASE TOMATO YIELDS

Thomas P. Davidson and Carl A. Larson, Hermiston.--In tomato fertilization trials on Yakima gravelly loam in the Milton-Freewater area, treatments of 150 pounds of P_2O_5 and 150 pounds of K_2O gave significantly lower total yields than no fertilizer. Average total yields for the treatments were as follows: No fertilizer - 19.3 tons per acre; 150 pounds of P_2O_5 - 16.7 tons per acre; and 150 pounds of K_2O - 15.7 tons per acre. The depressing effect of the P_2O_5 and K_2O was not significant in the marketable yields of the plots.

Oregon

FIELD CORN HYBRIDS DIFFER IN PROTEIN CONTENT

Carl A. Larson, Hermiston.--Seven hybrids grown in a factorial experiment of variety x stand x fertility showed that there were highly significant differences in protein content between hybrids. These hybrids were grown in 1954 on loamy sand soil following alfalfa.

Protein content of various field corn hybrids

Hybrid	Protein in grain
	Percent
1	8.75
2	8.70
3	8.19
4	8.98
5	9.08
6	8.94
7	8.69

Least significant difference:
at 5% level - 0.45%
at 1% level - 0.60%

Oregon

SUGAR CONTENT OF WATERMELONS UNAFFECTED BY FERTILIZERS

Thomas P. Davidson and Carl A. Larson, Hermiston.--Ten fertilizer combinations of nitrogen, phosphorus, and potassium failed to significantly affect the sugar content of the Blue Ribbon Striped Klondike watermelons grown on Ephrata loamy sand. Maximum rate of nitrogen was 300 pounds per acre; and of P_2O_5 and K_2O, the maximum rate was 100 pounds per acre. Average sugar content was 11.6 percent. The highest average percentage (12.6) was in the check plots where no fertilizer was applied; the lowest (10.4) was in the plots receiving 300 pounds of nitrogen and 100 pounds of P_2O_5 per acre.

California

NITROGEN DOES NO GOOD ON LATE GRAIN, IS HAZARD AFTER FALLOW

Maurice Donnelly and Arthur E. Laag, Riverside.--Reduction in the supply of nitrate nitrogen available to a grain crop at planting time is one of the most important primary effects of shifting from inversion tillage with complete burial of dead and living ground cover, as with the moldboard plow, to subtillage, as with V-blade sweeps. This has been shown previously. A representative set of data showing nitrate accumulation by inversion tillage and by subtillage is shown below.

Soil depth	Nitrate - nitrogen accumulation in soils receiving the indicated treatments	
	Subtillage (Sweeps)	Inversion tillage (Moldboard plow)
Inches	*p.p.m.*	*p.p.m.*
0-6.............	13.1	22.6
6-12............	1.5	3.4
12-18...........	1.3	2.4
18-24...........	1.0	1.5

The reduction in available nitrate supply accompanying subtillage is ordinarily reflected as a reduction in the total yield of grain. Data on yield, matching the above set of nitrate accumulation data, were 2,040 pounds per acre of barley grain on subtillage (sweeps) plots and 2,760 pounds per acre on inversion tillage (moldboard plow) plots.

In an effort to learn how to offset the reduced nitrate supply under subtillage, experiments have been carried out which included the application of commercial fertilizers. In all of the experiences here cited, the amount of nitrogen applied was in the range of 36 to 40 pounds per acre.

After dry season.--Technicians and cooperating ranchers raise questions as to the effect on yields and fate of the applied nitrogen if limited rainfall or unseasonally high temperatures or both occur. Some recent data are pertinent on this question.

Plots were laid out at Riverside employing 5 nitrogen carriers at a rate of 40 pounds of N per acre. Shortly after application and planting, rain practically ceased and later spring temperatures were unseasonally warm. This resulted in a yield pattern in which the check plots produced about as much oat grain as the fertilized plots. The yield was in the range of 600 to 700 pounds of grain per acre. The next year a heavy uniform stand of volunteer oats appeared on all plots. When cut for hay, the fertilized plots yielded approximately 2,500 pounds of oat hay per acre. The check plots, which produced more than would normally have been the case when oat hay immediately follows oat grain, yielded approximately 1,000 pounds of hay.

It is concluded, therefore, that when dry-farm grain is fertilized with nitrogen in a year when the rainfall and temperatures are so adverse that moisture becomes almost the sole limiting factor, the applied nitrogen is not wasted but becomes available, at least in part, to the succeeding crop.

Late grain.--A number of experiments were carried out in the fertilization of grain which for one reason or another was planted late. By late we mean well into January. On some of the plots, assay had shown that the nitrate accumulation at planting time was low--in one instance, in the range of 5 ppm nitrate nitrogen in the surface 6 inches of soil. Despite this low nitrate status, no effect on yield was measurable between the fertilized and nonfertilized plots under the conditions of late planting.

The simplest explanation for this lack of response appears to be that cold weather in late planting holds the young plants virtually at a standstill. By the time the weather warms up in the spring, there is enough nutrient supply in the unfertilized plots to support growth comparable with that of the fertilized plots.

Summer fallow. --This project has shown from a number of measurements on a number of different soils that the nitrate supply available to a planted grain crop following the cultural preparation described in the Pacific Southwest as summer fallow is quite variable, ranging in the surface 6 inches from 12 to 50 ppm nitrate nitrogen. Even where assays have shown available nitrate supply to be low under summer fallow, fertilizer applications have not given consistent results. We do not know exactly why this should be.

Our conclusions from all of the work that has been done is that it is a hazardous procedure to add commercial nitrogen to a field prepared for a grain crop by the conventional summer fallow method unless preplant nitrate nitrogen determinations show a definite lack of available nitrogen in the soil.

Utah

POTASH FERTILIZER HAS LITTLE EFFECT ON BEET YIELD OR SUGAR CONTENT

J. L. Haddock, Logan. --It was reported by Dunn and Rost (1) that potash fertilizers containing chloride caused significant reductions in the sugar content of beets. Tyson (2) reported that heavy applications of potash salts lowered phosphorus content of beet leaves and that, on soils deficient in potassium, additions of potash fertilizers caused marked increases in percentage of potassium in both leaves and roots.

Since we were planning to use muriate of potash as a blanket treatment over a large rotation experiment, we decided to study the influence of muriate of potash on sugar beet quality.

It will be seen in the accompanying table that yields of roots tend to be inversely related to increases in potash fertilization under the conditions of this experiment. This is also true for top yields, which averaged 8.35 tons per acre. However, there were no significant differences. Sucrose percentage is high and apparently unaffected by variations in potash fertilization. This is true also for purity, which averaged 93.84 percent.

Soluble nitrate-nitrogen and potassium tend to increase in petioles with increasing quantities of potassium fertilization at the first and second sampling. At the third sampling period, these soluble constituents were uniform and relatively low. Although 120 pounds of nitrogen per acre were applied to the crop, the sugar beets appeared to be low in nitrogen most of the season. It is evident that muriate of potash per se does not greatly affect the sucrose percentage.

There appears to be an interesting relationship between potassium and nitrogen utilization which will be given further consideration.

Yield, quality, and chemical composition of sugar beets as affected by potassium fertilization, 1955

Application of potassium per acre	Yield per acre	Sucrose content	Nitrate-N in petioles			Soluble K in petioles		
			7/15	8/29	10/15	7/15	8/29	10/15
Pounds	*Tons*	*Percent*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*
0..........	19.93	17.86	2480	2260	140	40,700	35,500	33,000
400........	19.33	17.88	3300	2300	180	43,600	37,100	32,200
800........	18.36	18.00	4900	2300	180	50,000	43,500	28,900
1200.......	17.81	17.92	5100	3500	140	53,000	50,280	33,000
Mean.......	18.86	17.91	3945	2590	160	46,825	41,595	31,775

(1) Dunn, L. E. and Rost, C. O. Influence of fertilizer on composition and quality of sugar beet. Minnesota Agricultural Experiment Station. Technical Bulletin 183, 1949.

(2) Tyson, James. Influence of soil condition, fertilizer treatments and light intensity on growth chemical composition and enzyme activities of sugar beets. Michigan Agricultural Experiment Station. Technical Bulletin No. 108, 1930.

Colorado

NITROGEN INCREASES PRODUCTIVITY OF RANCH'S MOUNTAIN MEADOWS

Forrest M. Willhite and Hayden K. Rouse, Grand Junction.--In 1954, the use of nitrogen on the Ferry Carpenter ranch near Hayden nearly doubled the carrying capacity and beef production of mountain meadows. Tentative results in 1955 indicate that approximately twice as many weaner calves were carried on the nitrogen-fertilized meadows as compared to unfertilized meadows of equal size. Nitrogen application rates per acre were approximately 200 pounds in 1954 and 160 pounds in 1955. In both years the applications were divided, one-half being applied in the spring and the second half being applied after the first cutting. In 1953 the original sward was approximately 20% orchard grass, 20% timothy, 20% bluegrass, 35% clover and 5% weed. After treatment with nitrogen, the sward is approximately 90% orchard grass and 10% bluegrass, while continuous grazing on unfertilized meadows has favored production of bluegrass.

Texas

CORN YIELDS DETERMINED BY WEATHER IN FERTILITY EXPERIMENTS

J. W. Collier and R. M. Smith, Temple.--Analyses were made on detailed corn yields in 9 factorial fertility experiments superimposed on 3 cropping systems in large runoff-erosion plots, during the years 1953, 1954 and 1955. Corn stands were about 10,000 plants per acre.

Analysis of variance of the 9 experiments showed no significant responses to fertilizer in any of the 3 systems. The only variable showing highly significant differences in each system was years, indicating the overshadowing effect of weather or season on corn yields.

The 3-year mean yields were 45.5 bushels for corn following cotton; 40.8 bushels for corn following phosphated oats with sweetclover; and 37.4 bushels for corn following 2 years of phosphated fescuegrass with sweetclover. The high 3-year average for corn following cotton was due, largely, to the 1955 yield of 69 bushels compared to 49 and 37 bushels, respectively, for the other 2 systems.

Moisture samples in May, June and July, 1955, show most available moisture for the corn following cotton and least for the corn following fescue with clover. Apparently, this moisture difference was largely responsible for the low yields following fescue with sweetclover, since soil nitrates to a 4-foot depth were higher following the fescue-clover than in the other 2 systems.

Total rainfall, by years, was as follows: 1953 - 34.9 inches; 1954 - 13.8 inches; 1955 - 37.1 inches. The 43-year mean at Temple is 34.0 inches.

In considering these corn yield results, a statement taken from the 1932 annual report of this station may be of interest. It is as follows: "The highest three plats in the 1932 corn fertilizer test yielded from 34.1 to 35.4 bushels per acre and each received 400 pounds of a 4-12-4 ratio. The four unfertilized plats averaged 32.2 bushels per acre while the 18 plats receiving varying amounts and ratios of fertilizer averaged 31.2 bushels. Considering the 5-year average, 1928-1932, inclusive, the results of fertilizer applications are as unpromising as those for 1932. The four plats receiving no

fertilizer during the 5-year period averaged 25.8 bushels per acre, whereas the 18 plats receiving varying amounts and ratios of fertilizer yielded 26.0 bushels."

During the 5-year period, 1951 through 1955, a total of 20 corn fertilizer experiments have been conducted under dryland conditions by the Blackland station. In these 20 experiments the average yield without fertilizer was 37.8 bushels compared to 40.7 bushels with 60-60-0 fertilizer. Average yields in the 1951-1955 period were 10 to 15 bushels higher than for 1928-1932. Average rainfall for the 2 periods was:

1928-1932	1951-1955
32.3 inches	29.0 inches

Higher yields during recent years are attributed, primarily, to adapted hybrids and closer spacings. Responses to fertilizer continue to be small. A period of years with rainfall above normal might result in greater responses to fertilizer.

New Mexico

NITROGEN GIVES BIG BOOST TO COTTON YIELDS

James A. Burr, Tucumcari.--Two off-station fertilizer experiments with cotton were conducted in 1955 on the Tucumcari irrigation project. Their purpose was to study further the response of cotton to nitrogen and phosphorus fertilizers. At each location, 4 rates of nitrogen and 3 rates of phosphorus (including 0 as one rate) were applied in all combinations giving a total of 12 treatments. All phosphorus used was 45% treble superphosphate and all nitrogen was 33% ammonium nitrate. The response obtained in these two experiments correlates very closely with data collected from similar cotton fertility experiments conducted in 1952 and 1953. Results from the two locations are as follows:

Yields of seed cotton associated with 4 rates of nitrogen fertilizer and 3 rates of phosphate fertilizer application on two farms in the Tucumcari irrigation project, New Mexico, 1955

Fertilizer treatment per acre		Yields of seed cotton per acre*	
Kind	Amount	Hinman farm	O'Quinn farm
Nitrogen	*Pounds*	*Pounds*	*Pounds*
	0	1,452	1,292
	40	1,767	1,812
	80	1,863	2,030
	120	1,912	2,185
Least significant difference (5% level)		131	150
P_2O_5			
	0	1,718	1,767
	40	1,742	1,863
	80	1,767	1,863
Least significant difference (5% level)		N.S.	N.S.

*Average of 6 replications.

The following conclusions can be drawn from the data obtained.

1. No significant response to phosphorus was obtained on either farm; however, there appears to be a trend toward a response in both cases.

2. On the Hinman farm, all rates of nitrogen applied were better than the check. The 120-pound rate was better than the check or 40-pound rate, and no difference occurred between the 80- and 120-pound rates.

3. On the O'Quinn farm, all rates of nitrogen applied were better than the check. Each additional increment of nitrogen applied gave a significant increase over the previous rate.

4. There was no interaction between the nitrogen and phosphorus fertilizer on either farm.

New Mexico

CORN RESPONDS TO FERTILIZER N, NOT TO P_2O_5 IN SAN JUAN COUNTY

Ross W. Leamer, State College.--Corn grown in San Juan county responds to nitrogen but not to phosphorus fertilizer. This is the conclusion drawn from a fertilizer trial conducted on the Oliver Stock farm near Waterflow. The fertilizers for this trial were broadcast before plowing in the spring of 1955 on land that had been out of alfalfa 2 years. Nine fertilizer treatments replicated 6 times were randomized in the area chosen for the trial. Nitrogen was applied as urea and phosphorus as treble superphosphate.

The calculated bushel yields from the various treatments applied to DeKalb 850 hybrid grown in San Juan County, are as follows:

Fertilizer treatment per acre		Yield of corn per acre
P_2O_5	Nitrogen	
Pounds	*Pounds*	*Bushels*
0...............	0	66.4
0...............	60	78.6
0...............	120	98.0
30..............	0	64.0
30..............	60	81.0
30..............	120	98.0
60..............	0	66.9
60..............	60	86.1
60..............	120	93.9
Averages:		
All rates.......	0	65.8
All rates.......	60	81.9
All rates.......	120	96.6

Least significant difference at 5% level: 2.1 bushels
Least significant difference at 1% level: 2.8 bushels

These data show a progressive increase in yield with increasing rates of nitrogen application. There is no consistent trend attributable to the phosphorus application. These observations are in agreement with other fertilizer trial results, which have indicated that phosphorus is not limiting current crop production in soils west of the Rio Grande valley in New Mexico.

North Dakota

IRRIGATION, FERTILIZER INCREASE BROMEGRASS YIELDS 4-5 FOLD

Carl W. Carlson and Russell J. Lorenz, Mandan.--The first yields comparing the effect of 3 moisture levels and 8 fertility treatments on the yield of brome and brome-alfalfa were obtained at Upham in 1955. Two harvest systems were used. Hay plots were harvested 3 times and pasture plots 6 times during the season. The moisture levels included dry, medium and wet. For the dry level, no water at all was applied. The medium treatment consisted of 5 irrigations and the wet treatment 7. The fertility treatments included 6 rates of nitrogen and 2 of phosphorus. Rainfall for 1955 was 12.8 inches. The mean for the area is 15.5. Rainfall during the growing season was about 2 inches below normal.

In most cases, irrigation doubled pasture and hay yields. The yields produced by the medium and wet treatments were about the same. Average daily water use was slightly higher on the hay plots than on the pasture plots. Daily use with no irrigation was only half that with irrigation. Inches of water required to produce a ton of forage was higher for the pasture plots than for the hay plots.

Inspection of the accompanying data reveals that pasture and hay yields from the dry treatment increased with increasing rates of nitrogen. Phosphorus failed to increase yields. The use of alfalfa in mixture with brome was equivalent in terms of hay yields to the application of 80 pounds of nitrogen and in pasture yields to 40 pounds of nitrogen.

Forage yields of bromegrass grown at 3 moisture levels under 7 fertility treatments and in mixture with alfalfa at Upham, N. Dak., 1955

Fertilizer treatment per acre		Average hay yields per acre				Average pasture yields per acre			
P_2O_5	Nitrogen	M_1[1] (Dry)	M_2 (Med)	M_3 (Wet)	Av.	M_1 (Dry)	M_2 (Med)	M_3 (Wet)	Av.
Pounds	*Pounds*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
200	0	0.93	1.51	1.46	1.30	0.83	0.93	1.14	0.97
200	40	1.34	1.93	2.82	2.03	1.24	1.58	1.65	1.49
200	80	2.22	3.24	3.59	3.02	2.16	1.85	2.22	2.08
200[2]	0	2.16	3.71	3.98	3.28	1.41	1.96	2.31	1.89
200	120		3.95	3.94	3.95		2.30	2.88	2.59
200	160		4.67	4.67	4.67		3.20	3.08	3.14
200	200		4.81	4.82	4.81		3.43	3.18	3.30
0	120		3.45	4.10	3.77		2.48	2.53	2.50

[1] No irrigation; rainfall only.
[2] Mixture of brome-alfalfa

Under the medium and wet irrigation treatments, pasture and hay check plots yielded about the same. Both pasture and hay forage yields increased with increasing nitrogen rates. The hay yields increased at a greater magnitude than the pasture yields.

Alfalfa included in the mixture was equivalent in terms of hay yields to the application of 120 pounds of nitrogen and in pasture yields to 80 pounds of nitrogen.

The results of this experiment suggest that, by the proper use of irrigation water and nitrogen fertilizer, brome grass hay yields can be increased 5 fold and pasture yields 4 fold in North Dakota in years such as this.

Nebraska

ZINC DEFICIENCY OF FIELD BEANS FOUND IN NORTH PLATTE VALLEY

R. R. Allmaras and F. E. Koehler, Scotts Bluff Experiment Station, Mitchell.--One foliar application of 1/2 percent $ZnSO_4$ was made to field bean plants at 13 sites in the irrigated North Platte river valley where zinc deficiency of plants was observed. Increases in yield of dry beans resulting from this foliar zinc spray are tabulated as follows:

Mean increase over no treatment from 1/2% $ZnSO_4$ foliar spray	Sites where response was obtained
Percent	*Number*
Less than 7	4
8 - 36	4
37 - 67	3
Greater than 67	2

The mean response from 1/2 percent $ZnSO_4$ foliar spray was 3.6 bushels per acre. No relationship was found between the magnitude of response and soil series.

In 1954 a lime-induced chlorosis (iron deficiency) was shown to exist in these same areas.

Future research will be directed toward use of soil applications of zinc and iron carriers to alleviate these deficiencies.

Nebraska

CORN MAY RESPOND TO NITROGEN SIDE-DRESSING IN DRY SEASON

R. E. Luebs, Lincoln.--Corn yields at Lincoln, were severely limited by lack of moisture in 1955. Yields were generally below 35 bushels per acre. However, in 2 of 3 field experiments, yields were significantly increased by application of nitrogen. Where the yield of unfertilized corn was 28 bushels per acre, maximum increases in yield were 8 bushels per acre from 40 pounds of nitrogen and 11 bushels from 80 pounds of nitrogen.

Corn was side dressed with ammonium nitrate when it was from two to three feet in height. Precipitation from the time of nitrogen application to September 15, when yield had largely been determined, was slightly less than 2.5 inches. This moisture came in 7 relatively light showers.

In one of the experiments where nitrogen response was obtained, corn followed second-year sweetclover in a rotation. Where corn followed first-year sweet clover, the corn crop was a complete failure because of prior moisture depletion by the legume, and any immediate benefit of nitrogen fertilizer was lost.

Alabama

EFFECTIVENESS OF ROCK PHOSPHATE VARIES WITH SOIL

R. W. Pearson, Auburn.--First-year results from field experiments of the Southern regional rock phosphate project have shown that there are wide differences in the response of crops to raw phosphates when used on different soils. These results confirm the belief that soil mineralogical and chemical properties are important factors in determining the relative effectiveness of raw and processed phosphates as fertilizers.

The following table presents data illustrating the differences found with one test crop, ladino and intermediate white clover:

Soil	Yield of clover (dry matter) per acre		
	From 120 lbs. P_2O_5 as superphosphate	From 300 lbs. P_2O_5 as rock phosphate	From 600 lbs. P_2O_5 as rock phosphate
	Pounds	*Pounds*	*Pounds*
Plummer sandy loam...........	2,206	362	341
Boswell fine sandy loam......	2,417	1,973	2,931
Wickham fine sandy loam......	4,500	3,777	4,098
Henry silt loam..............	4,156	3,581	3,876
Leon fine sand...............	5,550	3,354	3,752

On the Plummer soil, rock phosphate was practically worthless at both rates, while on the Boswell soil the higher rate was as effective as 120 pounds of P_2O_5 from superphosphate. Also, with the Boswell soil a sharp increase in yield resulted from the second increment of rock phosphate. The other 3 soils were intermediate between the Plummer and Boswell in their response to rock phosphate.

The regional study from which these results were taken, is being carried out by the Eastern Soil and Water Management Section, in cooperation with the agricultural experiment stations of Alabama, Arkansas, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia at 19 locations. It is designed to evaluate rock phosphate as a source of phosphorus for forage crops grown on the acid soils of the Southeast, to determine its long time residual effect and to relate the field response found to soil properties in such a way that conditions favorable to its use can be stated definitely.

SOIL STRUCTURE

North Dakota

LODGING OF WHEAT MAY BE PARTLY DUE TO LOOSE SOIL

Howard J. Haas and Julius S. Hayes, Mandan.--A high wind and heavy rain on July 28 caused considerable lodging of wheat when it was near maturity. Studies made in a seed block revealed that strips of wheat uniformly spaced across the field were standing, whereas the wheat between the narrow strips was lodged. Seeding had been done with an ordinary drill without press wheels. The narrow strips of standing wheat coincided with the drill wheel marks, indicating that resistance to lodging was influenced by the packing effect of the drill wheels at seeding time. Thus, lodging of wheat may be due not only to an inherent weakness of the stem but also to a loose soil condition which is unable to support the plant in an upright position.

Samples were taken from the non-lodged and the lodged grain for yield and test weight determinations, and the average results were as follows:

	Non-lodged	Lodged
Total wt., pounds per acre	3,530	2,340
Grain yield, bushels per acre	22.2	14.7
Test wt., pounds per bushel	57	56

Since the wheat was nearly mature at the time lodging occurred, it is doubtful that the difference in yield was entirely due to lodging; it was probably due in part to the better stand of wheat in the non-lodged strips.

These results indicate that firming the soil at seeding time, such as is done with press wheels, may not only result in better stands and higher yields of wheat, but may also reduce the amount of lodging under some conditions.

CROPPING SYSTEMS

Texas

CONSERVATION PRACTICES INCREASE COTTON YIELDS 93-132 PERCENT

J. B. Pope, Waco.--The average lint cotton yield from four different cropping systems with conservation measures more than doubled the yield from conventionally farmed areas on the station in 1955. The differences in cotton yields between the conservation cropping systems and the conventional system reflect the cumulative effects of the different systems since they were placed in operation in 1943.

The conservation-farmed areas are terraced and farmed on the contour with a legume crop included and with commercial fertilizer added at different rates per acre.

The conventionally farmed areas were not terraced, did not have a soil improving legume in the system, nor soil amendments added, and had straight-row cultivation.

Lint cotton yields per acre from improved cropping systems compared with conventional cropping system of the area, Waco, Tex., 1955

Cropping systems	Average yield per acre	Yield increase over conventional cropping
Without conservation methods	*Pounds*	*Percent*
4-yr: Cotton, oats, cotton, corn; no fertilizer or clover in system........	154.5	------------------
With conservation methods		
2-yr: Cotton, oats-clover with 100 lbs./A 0-45-0 fertilizer applied at time of seeding oats-clover..................	358.4	132
3-yr: Cotton, oats-clover, corn-winter peas, with 100 lbs./A 0-45-0 fertilizer applied at time of seeding oats and clover, and winter peas...............	305.3	98
3-yr: Cotton, grain sorghum, oats-clover, with 200 lbs./A 16-20-0 applied at time of seeding oats-clover...........	297.7	93
4-yr: Cotton, grain sorghum, oats-clover, clover-volunteer oats, with 200 lbs./A 16-20-0 to oats-clover at time of seeding oats-clover......................	330.9	114

North Carolina

VETCH RESIDUES ARE BENEFICIAL FOR SEVERAL YEARS

W. V. Chandler, University Park, Pa. (Work conducted in North Carolina).--The residual value of vetch on Norfolk sandy loam soils in North Carolina is apparent for at least five years. Studies on the residual value of cover crops grown for a period of years were started in 1950 or later years on experiments which had been in cover crops annually since 1944. The plots reported herein had received the same fertilizer applications and treatments except for the vetch cover crop during the period 1944 to start of residual studies. The cover crop was discontinued on the Ryan McBryde (RMcB) farm in 1950, John Parker (JP) farm in 1951, D. F. Peidin (DFP) and Rocky Mount (RM) farms in 1953. The plots were split with one-half receiving no nitrogen application and the other half receiving adequate nitrogen for the subsequent crop grown. All plots continued to receive high rates of phosphate and potash. A two-year rotation cropping system consisting of oats-grain sorghum-corn was followed when climatic conditions would permit. Four replications were run each year on all except the RM farm where only three replications were run.

The yields by locations are shown in the table. The yields in general have been below normal due to unfavorable climatic conditions. This was particularly true during the third and fifth years.

It is significant that in the first year following vetch cover crops, additions of nitrogen may be harmful, particularly if moisture is at all limiting. This may be true even five years later.

Average yields of oats, grain sorghum, and corn in studies on residual effects of cover crops, North Carolina, 1950-55

Year after cover crop	Crop and Treatment	Yields per acre by locations				
		RMcB	JP	DFP	RM	Average
First						
	After no cover:	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
	Oats without added N		28.9			
	Oats with added N		70.0			
	Corn without added N			3.4	24.2	13.8
	Corn with added N			34.2	47.2	40.7
	After vetch:					
	Oats without added N		62.2			
	Oats with added N		[1] 47.2			
	Corn without added N			31.1	49.1	40.1
	Corn with added N			[2] 15.5	62.9	39.2
Second						
	After no cover:					
	Oats without added N	13.3	19.5	5.9	15.9	13.7
	Oats with added N	39.7	93.8	64.6	43.6	60.4
	Sorghum without added N	4.8	[3] 26.6			15.7
	Sorghum with added N	23.3	[3] 30.8			27.0
	After vetch:					
	Oats without added N	44.2	47.1	30.6	43.6	41.4
	Oats with added N	50.3	96.1	66.2	60.5	68.3
	Sorghum without added N	10.8	[3] 33.9			22.3
	Sorghum with added N	26.4	[3] 28.6			27.5

See footnotes at end of table.

Average yields of oats, grain sorghum, and corn in studies on residual effects of cover crops, North Carolina, 1950-55--Continued

Year after crop	Crop treatment	Yields per acre by locations				
		RMcB	JP	DFP	RM	Average
		Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Third						
	After no cover:					
	Corn without added N	6.8				
	Corn with added N	30.2				
	After vetch:					
	Corn without added N	22.2				
	Corn with added N	45.8				
Fourth						
	After no cover:					
	Oats without added N	12.9	13.7			13.3
	Oats with added N	45.9	44.6			45.2
	After vetch:					
	Oats without added N	30.4	18.3			24.3
	Oats with added N	58.3	47.7			53.0
Fifth						
	After no cover:					
	Oats without added N	[4] 9.6				
	Oats with added N	[4] 18.2				
	After vetch:					
	Oats without added N	[4] 24.5				
	Oats with added N	[4] 11.9				

[1] Excessive nitrogen--severe lodging prior to seed development.
[2] Dry year--nitrogen on vetch residue was excessive.
[3] Too dry for good yields.
[4] Very dry in late season--additional nitrogen detrimental.

Chemical and physical studies of these soils during the previous cropping history or at the start of the residual studies showed no significant differences between the no-cover-crop and vetch plots. However, there was a tendency toward higher organic matter and total nitrogen in vetch plots. Observations of plots did show a definite darker tint in soil color of the vetch plot on the McBryde farm, which was a very light loamy sand.

These data emphasize that growing a legume cover crop in the cropping system gives benefits in addition to its direct effect, the fixation of nitrogen for release to subsequent crops. The value of a legume cover crop preceding many crops such as tobacco or cotton may be questionable; however, if grass crops which are capable of utilizing high rates of nitrogen are to be grown, the legume cover crops are definitely beneficial. More difficulty and less beneficial results were experienced in production of crops following an oat cover crop than a vetch cover crop.

Oregon

"MAUL THOSE MULCHES AND SEED RIGHT THROUGH THEM"

T. R. Horning, Pendleton.--Mulches up to 12,000 pounds per acre gave very little difficulty in preparing a seed bed and seeding winter wheat after summer fallow. Four main treatments with split plot design replicated four times were used as follows:

1. Stubble burned.
2. 4,000 pounds of residue left from previous crop.
3. 4,000 pounds straw added to 4,000 pounds previous crop residue.
4. 8,000 pounds straw added to 4,000 pounds previous crop residue.

Sub-plots included 8 different fertilizer treatments. Four plots were burned surrounded by a firebreak for safety. After planned proportions of straw were added, all plots were mulched 3 times with a stubble buster. To prevent wind movement of straw, the mulch was partially tucked into the soil with a rotary spade run with gangs closed.

After varying kinds and amounts of fertilizer were applied, all plots were subsurface tilled with a 2-blade 11-foot sweep at 3-inch depth. The soil and mulch were mixed to aid decomposition by using the rotary spade with the gangs in open position. Later all plots were subsurface tilled again at 8-inch depth to provide a loosened seed bed.

Volunteer wheat and cheatgrass were controlled by 3 rod weedings during summer months. No plugging was experienced in seeding wheat with a deep furrow drill having 14-inch spacing of shoes.

Equipment operations are summarized as follows:

Operations	Number of operations
Stubble buster	3 times
Rotary spade	2 times
Sweep	2 times
Rod weeder	3 times
Total	10

This experience showed that abnormal amounts of mulch can be handled and seeded through without too much difficulty although a considerable number of tillage operations are involved. Enthusiasts for mulch tillage put the results of this work into general advice: "Maul those mulches, and seed right through them."

Texas

SORGHUM STUBBLE KEEPS SOIL BLOWING TO A MINIMUM

W. C. Moldenhauer and Wyatt Lipsomb, Big Spring.--A trial of methods designed to utilize sorghum stubble for prevention of wind erosion while a new sorghum crop was being planted and cultivated was carried out in 1955 on the Leon Clanahan farm at Tokio.

At the time the trial was begun, the field had a cover of approximately 700 pounds of grain sorghum stubble (washed, oven-dry basis). This stubble, approximately 12 inches high, was all standing in 40-inch rows. The stand was excellent in each row. This was an exceptional situation for the area west of Brownfield.

This stubble kept soil blowing to a minimum except where a row had been skipped. Here several inches of the surface soil had blown into adjacent stubble.

The first operation on this land was carried out March 28 with 30-inch sweeps run 6 to 8 inches deep on a Dempster carrier. (Figure 1.) Very little stubble was covered whether the operation was with the rows or across the rows. The second operation was on June 10 to kill volunteer sorghum and weeds. The sweeps were run 3 inches deep. At this depth, going across the row, the amount of stubble exposed was reduced from 700 to 400 pounds per acre and most of it was laid down by the operation. About 3/4 of the field was done this way. This cover was found to be inadequate protection against blowing. It was found that by setting the sweeps so they barely overlapped and by going with the row, practically all of the stubble was left standing. One-fourth of the field was cultivated in this manner. This latter method did not control volunteer sorghum as well as the former. However, the remaining volunteer sorghum was killed at the first knifing operation.

Figure 1. --Three 30-inch sweeps mounted on a tool bar were used for sub-tillage operations.

Planting in stubble. --All planting in 1955 on stubble mulch and narrow-row-spaced plots was done with Dempster Plant-all units because of the ease of adjustment to various row spacings and the fact that these units have interchangeable lister bottoms and disk furrow-openers with sword type runner. (Figure 2.) For 20-inch row plantings where no stubble was to be encountered, the wings were cut off 10-inch Kelley bottoms and these were used on the Plant-all units. This makes an expensive set of bottoms and the job done is not enough better than that of the disk furrow openers, providing the disk unit is used as soon as possible after a rain. The layer of loose dry sand is not covered satisfactorily by these disks, and it is necessary to work sandy soils at a high moisture content in order to form clods for protection against soil shifting. It is also necessary to plant deep enough that a furrow will be formed for protection from sand blasting if adequate stubble is not present.

Cultivation. --The most successful cultivation of sandy soils for 20-inch row sorghum is done before planting. If weeds can be pretty well controlled before June 15 planting, little cultivation is necessary after planting under dryland conditions. However, one cultivation seems to be essential not only to kill weeds but to put some soil around the base of the plant to decrease the rate of drying out after small showers in this zone. It was found that a set of short knives answered this purpose very well. They were superior

to a spike-tooth harrow because of their effectiveness in cutting off volunteer sorghum. They are superior to cultivator sweeps because they offer less danger of cutting off sorghum roots, and the knives drag little or no stubble. It may be necessary to run over the small plants if the ridge between the rows is pronounced. No appreciable loss of stand was observed when this was done.

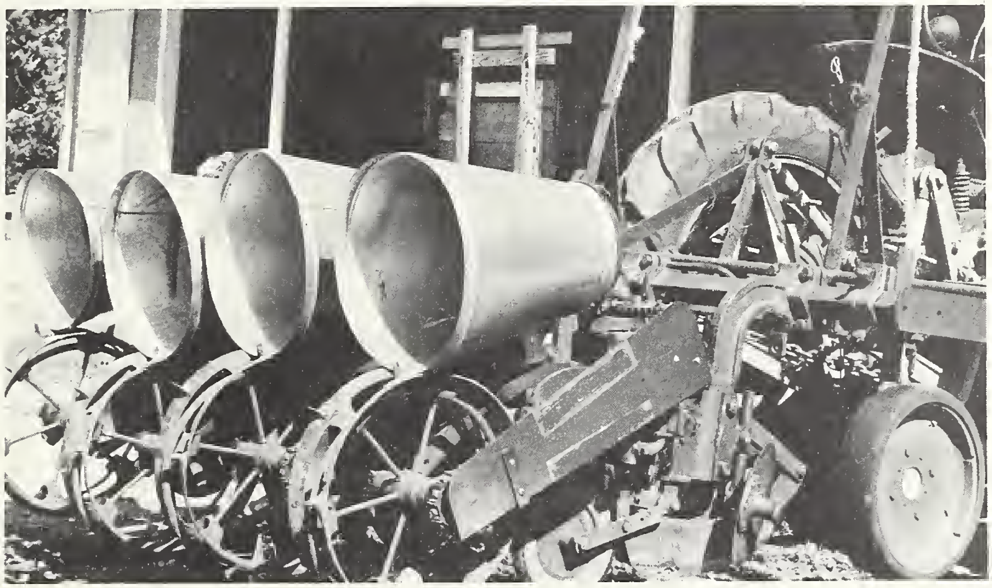


Figure 2. --Seeding was done with a Plant-all which is equipped with double disk openers and rubber tired press wheels just behind the runner.

Ohio

MULCH TILLAGE APPEARS PROMISING FOR CORN IN OHIO

H. L. Borst, Wooster. --Mulch tillage and conventional plowing have been compared for seven years in a 4-year rotation of corn, wheat and 2 years of grass-alfalfa meadow. The meadow sod was worked with a heavy field cultivator which left the meadow residue in and on the surface. In preliminary and later work various means of preparing a suitable rootbed for corn were investigated. Admittedly, what constitutes an ideal rootbed for corn is not known. The conventionally prepared rootbed has been used as a basis for comparison. Wooster silt loam on which these studies were located is in a fairly high state of fertility. Good alfalfa-grass sods have been available each year. The fertilizer program has been liberal enough to supply more than the nutrient requirements for top yields for conventional culture.

Yield data are given in the accompanying table.

Effect of rootbed preparation on corn yield

Treatment	Yield of corn per acre*								
	1949	1950	1951	1952	1953	1954	1955	Averages 7 Yr.	Averages 2 Yr.
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Turn plow preparation............	119	102	92	109	82	83	107	99	95
Mulch tillage (1).	108	102	94	107	77	81	100	96	90
Mulch tillage (2).	---	---	---	---	---	86	106	--	96

*15.5 percent moisture
(1) Conventional row fertilization.
(2) One-half row fertilizer at conventional depth, one-half at 5-inch depth.

Mulch tillage in this test, like similar work in the humid section of the Corn Belt, has produced yields which average slightly below those from conventional plowing. However, the yield differences from the two systems are not statistically significant. Potash and nitrogen deficiency in corn on mulch-tilled soils have been reported by other workers. There has been no response to additional nitrogen applications in the present experiment. Although some potash deficiency was observed on mulch-tilled plots in preliminary work (prior to 1949), there has been none in later years. There was no significant difference between the potash content of conventionally grown corn plants and those produced with mulch tillage in 1954 and 1955. Analyses for potash were not made in previous years.

For the past two years, the row application of fertilizer (400 pounds per acre of 3-12-12) has been split and one-half applied at a depth of 4 to 5 inches. This treatment has resulted in yields 5 to 6 bushels above those produced by conventional row fertilization.

MOISTURE CONSERVATION

Washington

WHEAT AFTER GREEN MANURE DOES BEST IN PALOUSE IN DRY YEAR

Glenn M. Horner, Pullman.--Wheat yields from clover-nitrogen plots were much lower in 1955 than in 1954. The decrease is attributed primarily to a moisture deficiency.

Wheat following sweetclover green manure yielded only 33.6 bushels per acre compared with 76.5 in 1954 and the 53.1 bushels recorded as a 10-year average from another group of plots on comparable land. However, the wheat following green manure in 1955 outyielded fertilized wheat following either peas or wheat.

Wheat following peas and wheat following wheat, despite drought injury, responded slightly in 1955 to nitrogen fertilizer. In 1954 when moisture conditions were favorable for wheat growth, applications of nitrogen fertilizer resulted in marked increases in yield of wheat following peas or wheat.

A summary of wheat yields on the clover-nitrogen plots for 1954 and 1955 is given below.

Crop grown in preceding year	Fertilizer nitrogen applied per acre*	Wheat yields per acre	
		1954	1955
	Pounds	*Bushels*	*Bushels*
Peas.................	None	41.9	19.7
Peas.................	70	51.5	23.6
Wheat................	None	24.1	21.0
Wheat................	70	----------	26.9
Sweetclover (green manure).....	None	76.5	33.6

*Applied at seeding time (October)

The amount of moisture in the soil at the beginning of the 1955 growing season was substantially below normal because of less precipitation, blowing of snow from exposed areas, and large runoff losses on frozen soil. A shortage of rain in May and June contributed to the moisture deficiency. There was no precipitation from May 29 to June 27.

At the heading and blooming stages, the wheat plants showed marked vegetative firing. They made some recovery after 1.57 inches of rain between June 28 and July 9.

Wide differences in the amount of vegetative firing were observed for the different treatments. The most severe injury occurred where peas were grown in 1954 and 70 pounds per acre of nitrogen were applied in October of 1954. Wheat grown on land where a green manure crop of sweetclover was turned under in June, 1954, had the least amount of firing. This is explained on the basis that larger amounts of moisture are stored in sweetclover land than in the soil under other treatments. Soil moisture data obtained during previous years showed that sweetclover green manure land had from two to three inches more water in the root zone in August than land cropped to wheat or peas.

Idaho

WINTER AFTER HARVEST CRITICAL IN STORING MOISTURE FOR NEXT WHEAT

F. H. Siddoway, St. Anthony.--Subsoil tillage in the fall of 1953 resulted in no appreciable differences in available soil moisture content in the spring of 1954. However, a rather wide range of available soil moisture values in the various plots afforded an opportunity to make a follow-up study to determine what happened to this available soil moisture between the first moisture sampling (5/17/54, prior to summer fallowing) and the last sampling (5/23/55, the spring of the crop year). Moisture samples were also taken 8/28/54 at the end of the fallow season. The following table summarized the information pertinent to the available soil moisture measurements.

Sampling date	Time in cropping sequence	Precipitation between sampling dates	Available soil moisture, 6" depth
		Inches	*Inches*
9/15/53	Following harvest of oat crop		0.00
		7.52	
5/17/54	Beginning of summer fallow season		4.53
		5.00	
8/28/54	End of summer fallow season (winter wheat planting time)		4.39
		6.38	
5/23/55	Beginning of crop year, winter wheat approximately 5" high		5.06

It is noted there was:

1. A net average gain in soil moisture from 1953 harvest to the spring of 1954 of 4.53 inches during which time 7.52 inches of precipitation were received.

2. An average loss of .14 inch during the fallow season of 1954 when 5 inches of precipitation were received.

3. An average gain of only .67 inch for the second winter period (1954-55) when 6.38 inches of precipitation were received. The difference of 5.71 inches of precipitation is assumed to have been lost through evapo-transpiration and runoff during the fall, winter and spring period.

There was a tendency for the available moisture differences that were present at the first sampling (5/17/54) to become narrower by the last sampling date (5/23/55).

Even though high-moisture plots were inclined to lose moisture and the low-moisture plots were inclined to gain moisture during the total period, the available soil moisture at the beginning of the crop year was dependent to a large degree on the soil moisture intake during the period between harvest and the following spring. These data

stress the importance of utilizing all conservation practices possible to increase soil moisture intake prior to the summer fallow period.

North Dakota

SHADING BY PLANTS MAY REDUCE EVAPORATION FROM SOIL SURFACE

Glen H. Cannel and Howard J. Haas, Mandan. --Loss of soil moisture from uncovered and covered wheat plots during a growing season has been determined by soil sampling.

The plots were sampled by 6-inch depths from 0 to 48 inches and by 12-inch depths from 48 to 72 inches. Strips of waterproof paper (trade name Sisalkraft) the length of the plots (10 feet), were cut to fit snugly over mounded soil between the wheat rows. Small paper strips were placed between and close to wheat plants perpendicular to the rows of wheat. They were joined to the long paper strips by plastic tiling cement. Only small spaces near the wheat plants were not covered by paper, and these were somewhat covered by placing pea-size gravel to a depth of 3 inches along each wheat row. The cover was placed in position when the plants were approximately 6 inches high.

One of the objects of the experiment was to determine whether shading at various growth stages of wheat plants was effective in reducing evaporation from uncovered plots. Comparative evapo-transpiration losses from the 0- to 6-inch depth of covered and uncovered plots for different growth periods were as follows:

Treatment	Loss of water* from the 0 to 6" soil layer between time intervals of-			
	6/13 to 6/20	6/27 to 7/5	7/8 to 7/21	8/1 to 8/25
	Inches	*Inches*	*Inches*	*Inches*
Covered....................	0.63	0.92	0.95	0.79
Uncovered..................	0.64	0.90	1.09	1.04
Difference.................	0.01	-0.02	0.14	0.25
Rainfall during each period**	0.09	0.72	0.32	0.76

*Each value is an average for three plots.
**Rainfall at any one time was less than 0.5 inch and there was no runoff from either the covered or uncovered plots.

The difference in loss of water from the uncovered and covered plots is represented as water lost by evaporation. It appears from the data that shading by the plants on the uncovered plots may have reduced evaporation to the level of that on the covered plots during the first 2 periods. Larger differences between treatments exist when the plants begin to mature and the leaves start to dry. Dry straw weight for the covered plots was greater than for uncovered plots, but the straw weights were not statistically different. How much effect the increased growth of plants on covered plots had on moisture loss was not determined. No correction was made for vapor loss through the small openings near the wheat plants in the covered plots.

RELATIONSHIPS BETWEEN CLIMATE AND COTTON, KAFIR YIELDS COMPUTED

W. C. Moldenhauer and F. E. Keating, Big Spring.--An attempt has been made to determine relationships between cotton and kafir yields and amount of moisture available for evapotranspiration during the growing season. Moisture available for evapotranspiration comes from precipitation during certain periods before the growing season and during the season. Seasonal and preseasonal periods were determined by simple correlation of the data collected between 1916 and 1954 at the Big Spring Field Station.

For cotton production, September precipitation is not important during the season of growth but is important to the following year's crop. This has been confirmed by work at the Weslaco, Tex., station which shows that water use by cotton drops off to a low rate immediately after the first open-boll stage. The period of seasonal growth for kafir varies with the distribution of seasonal moisture. If growth is retarded in July and late rains bring on the crop, it may not mature until late October or November. Otherwise it will mature in September.

Effective preseasonal moisture was determined by relating preseasonal precipitation to available soil moisture values. This relationship was as follows, letting M represent the available soil moisture in inches and P the preseasonal precipitation in inches (Sept. 1-May 1 for cotton and Oct. 1-June 1 for kafir): For cotton--$M = -0.59 + 0.163P$; for kafir--$M = 0.0301\ P^{1.345}$.

Seasonal precipitation available for evapotranspiration was determined from available soil moisture determinations before and after rains. This was calculated for individual rains and estimated for monthly rainfall figures according to the following table:

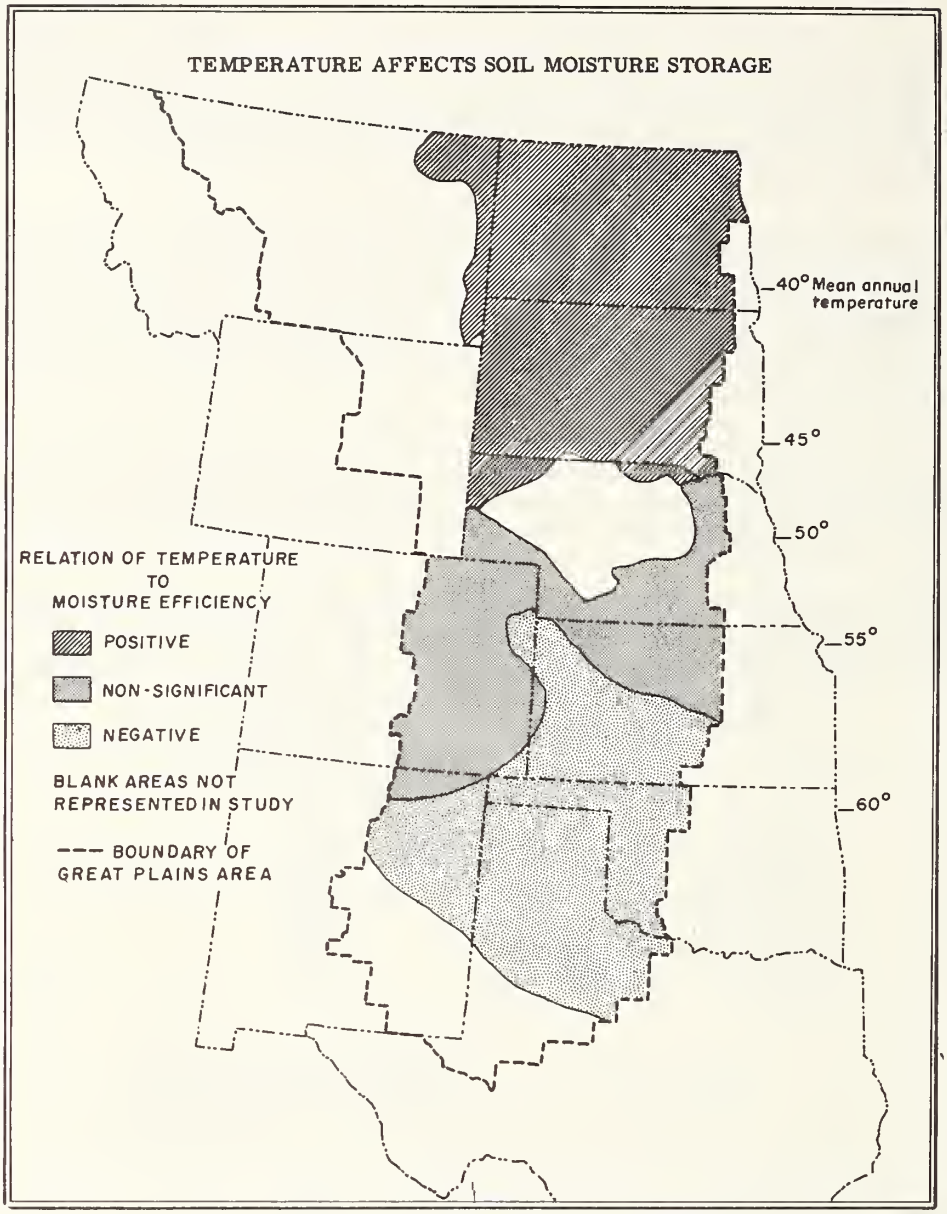
When an individual rain is-	Portion available for evapotranspiration is-
Less than 1 inch--------	100%
1-2 inches--------------	70%
2-3 inches--------------	60%
3-4 inches--------------	50%
4-6 inches--------------	40%
More than 6 inches------	30%

When monthly rainfall is-	Portion available for evapotranspiration is-
Less than 1 inch--------	100%
1-2 inches--------------	90%
2-3 inches--------------	80%
3-4 inches--------------	70%
4-6 inches--------------	50%
More than 6 inches------	40%

Effective seasonal and preseasonal values were added together to give a value for total precipitation available for evapotranspiration. The correlation coefficient obtained between this figure and cotton yields was 0.831; for kafir the coefficient was 0.765.

It was found in the course of this study that yields from an Amarillo loam soil were considerably lower than from Amarillo fine sandy loam over the 39-year period. On

Amarillo loam, preseasonal precipitation was more important to crop yield compared to the seasonal precipitation than it was on the Amarillo fine sandy loam soil.



This map, representing an analysis by H. H. Finnel of Goodwell, Okla., shows natural climatic areas in the Great Plains.

In the indicated portion of the southern plains, the various soils store more of the moisture that falls during a pre-crop period when the mean temperature is low than when it is higher. This is probably because evaporation is lower when mean temperature is lower.

In the northern plains, on the other hand, higher mean temperature favors storage of moisture in the soils during pre-crop periods. This is probably because less moisture is lost by runoff from forzen ground when temperatures are relatively high.

In the indicated central plains area there is no definite correlation between temperature and moisture efficiency.

More cropping alternatives are available in the southern plains than in the north; the preparatory period for a crop there may vary greatly in length between the extremes of a part of a summer to 30 months. The correlation between mean temperature and moisture efficiency applies to a preparatory period of any length.

Kansas

BURNING PASTURES DECREASES INFILTRATION OF WATER

R. J. Hanks and F. C. Thorp, Manhattan.--Water infiltration rates have been determined on native bluestem pasture soil with different burning treatments. As shown in the table, the infiltration rate on the non-burned remained high for about 80 minutes and then dropped off sharply while the infiltration rate or the December burned and the April burned plots dropped off after about 20 minutes. Buring at any time appears to have decreased the infiltration rate, but the time of burning did not affect the infiltration rate.

Infiltration rate per hour at the indicated time intervals (minutes):

Treatment	10	20	30	40	50	60	70	80	90
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
No burning........	4.6	4.4	4.4	4.4	4.4	4.4	4.4	2.6	2.0
December burning..	4.7	3.4	3.0	2.9	2.9	2.8	2.7	2.2	1.8
April burning.....	4.7	3.4	3.0	2.9	2.9	2.8	2.7	2.2	1.7

These same practices have been used continuously for over 25 years. At the time the infiltration rates were determined the soil was very dry. This accounts for the high infiltration rate.

A rain simulator was used to make the tests.

Kansas

INFILTRATION NOT AFFECTED BY DEEP CHISELING

R. J. Hanks and F. C. Thorp, Manhattan.--Infiltration rates have been determined at several locations in Kansas which have had various deep chiseling treatments. At no location did any type or depth of chiseling result in any increase in the infiltration rate over that of the check. These results compared closely with those obtained last year. Two of the locations had sandy soils with definite compacted layers. The other locations were on a silty loam and silty clay loams. Tests were made with a rain simulator.

Kansas

HEAVY RAIN PENETRATES CROPPED LAND MORE READILY THAN FALLOW

Paul L. Brown, Hays.--Heavy rainfall in September, 1955, provided an excellent opportunity to study rainfall penetration under several soil conditions. Rainfall for the month measured 7.63 inches, compared to an average of 2.20 inches. This was the wettest September on record with rainfall records dating back to 1868. The big rain of the month was 5.26 inches, which was the greatest amount of precipitation ever recorded in a 24-hour period at this station. More than 3 inches of this amount fell in a period of one hour. The soil is Yocemento silty clay loam and has an available moisture capacity of approximately 2 inches per foot depth of soil.

A stubble mulch tillage experiment had been initiated in July as a means of seedbed preparation for milo following fallow wheat. This soil was dry to a depth of at least 6 feet prior to the rain. Rainfall penetration was determined on October 8 by use of the soil moisture probe developed at this station. An average of 10 moisture depth determinations per plot showed the following depths of moist soil.

Type and time of tillage	Depth of moist soil
	Inches
Noble blade 3-4" in July..........	33
Oneway 4" in July.................	30
No tillage........................	29

The depths of moist soil were not significantly different.
Coefficient of variation--12.2%.

With the soil wet to 30 inches, about 5 inches of moisture was stored. There was very little evidence of runoff from any of the plots.

Another experiment involved methods of seedbed preparation for continuous wheat. The area had been in wheat in 1954-55. Moisture depths were determined in the same manner as in the above experiment. This soil was also dry to a depth of at least 6 feet prior to the September rains. The area had been tilled only once in July. The results of the moisture depth determinations are as follows:

Type and time of tillage	Depth of moist soil
	Inches
Oneway 3-4" in July...............	28
Plow 5" in July...................	27
Duckfoot 3-4" in July.............	24
Sweeps 3-4" in July...............	27

Coefficient of variation--18.8%.

Here again the depths of moist soil were not significantly different for the various methods of seedbed preparation.

In a third experiment effects of 3 methods of fallow for wheat were compared. The area had produced a wheat crop in 1954, and fallow operations were started in May, 1955. The plowing operation was followed by disking in June and rodweeding in August. The onewaying operation was followed by a second onewaying in June and rodweeding in August. The stubble mulch tillage consisted of undercutting with 30-inch sweeps in May, duckfooting in June and rodweeding in August. Soil moisture probing prior to the rain indicated moist soil to a depth of 2 feet. The results of the moisture depth determinations are as follows:

Fallow tillage	Depth of moist soil
	Inches
Plow..............................	25.5
Stubble mulch tillage.............	34.6
Oneway............................	25.1
Average......................	28.4

Least significant difference (5% level)--4.7 inches.
Coefficient of variation--11.3%.

The stubble mulch tilled fallow plots were wet to a greater depth than either the plowed or onewayed plots. The surface of the stubble mulch tilled plots remained wet for 2 days longer than did the plowed and onewayed plots. The surface of the plowed and one-way plots ran together and sealed over while there was no evidence of this on the stubble

mulch tilled plots. Erosion was apparent on the plowed and oneway plots but not in the stubble mulch tilled plots.

The comparisons of fallow tillage were made on plots being used in an experiment with a 3-year rotation of fallow-wheat-wheat. Adjacent to this block of plots was the block for second-year wheat. This block had produced wheat in 1955 and had been onewayed in July in preparation for the second-year wheat. Moisture depths were determined at the same time in the same manner as on the fallow plots. This soil was dry to a depth of several feet prior to the September rains. These plots showed an average depth of moist soil of 36 inches. There was more moisture in the cropped land than in the adjacent fallowed land. The surface of the onewayed cropped land was quite rough at the time of the September rains and there was also considerable straw which had been only partially buried. There was no evidence of runoff on these plots. The onewayed cropland was thus able to store about 6 inches of the 7.53 inches that fell while the fallow soil was able to store less than 2 inches. Wheat was sown on these 2 blocks in October. It will be interesting to see the resulting yields.

The conclusions drawn from these experiments are:

1. Fallowed soils such as these, wet to a depth of 2 to 3 feet, are very slowly permeable to water.

2. These same soils in a dry condition and with a degree of cover and surface roughness will take in water rapidly.

The Tocemento silty clay loam appears to be representative of a large body of soils in north central Kansas. The subsoils range from blocky, silty clay loams to silty clay. These subsoils, when dried out by growing crops, develop many cracks. These cracks admit water rapidly but apparently swell shut in a short time. This would explain how the cropland soil was able to store much more of the September rains than did the fallow soil.

TILLAGE AND CULTURAL PRACTICES

Montana

FIVE FALLOW METHODS RESULT IN SIMILAR SPRING WHEAT YIELDS

J. F. Power and G. A. Schumaker, Sidney.--A study was initiated in 1949 in northeastern Montana to evaluate the effects of various methods of summer fallowing on the yield and quality of spring wheat.

The fallow treatments used were as follows: (1) moldboard plow plus rodweeder; (2) oneway disc plus rodweeder; (3) subsurface tillage (stubble mulch); (4) subtill after harvest, subtill following summer; and (5) subtill during summer, chisel in fall before seeding.

The 7-year averages as shown in the table indicate that the type of summer fallow treatment had little effect on spring wheat yields. A difference of only 1.4 bushels exists between the highest and lowest averages.

During the first several years of the experiment, yields for Treatment No. 1 (plowed fallow) were generally greater than for No. 3 (stubble mulched fallow). However, within the last 3 years, a reversal has taken place and yields from stubble mulched plots have been greater than those from plowed plots. A possible explanation for this reversal is that erosion, particularly by wind, has been much more severe on the plowed plots.

There were no differences of any commercial consequence in the average protein content of grain produced under the different fallow treatments tested. Average protein

content of grain for plowed fallow was 15.4 percent and for stubble mulch fallow was 14.9 percent.

Spring wheat yields from plots fallowed by 5 different tillage methods at Moen farm, Culbertson, Mont., 1949-55

Treatment*	Yield per acre by years-							Average yield per acre
	1949	1950	1951	1952	1953	1954	1955	
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
1	18.7	34.9	18.9	18.3	18.3	12.6	27.0	21.2
2	16.6	33.0	18.0	15.2	19.0	14.0	27.6	20.5
3	14.5	28.1	19.8	15.6	24.7	14.7	28.0	20.8
4	14.5	29.4	18.8	15.0	22.1	13.5	25.4	19.8
5	14.5	25.6	18.9	17.2	23.1	14.4	30.1	20.5

*Fallow treatments were as follows:
No. 1 - Moldboard plow plus rodweeder
No. 2 - Oneway disc plus rodweeder
No. 3 - Subsurface tillage (stubble mulch)
No. 4 - Subtill after harvest, subtill following summer
No. 5 - Subtill during summer, chisel in fall before seeding

Nebraska

STUBBLE MULCH SHOWS BEST RESULTS IN YEARS OF LIMITED RAINFALL

F. L. Duley, Lincoln.--Corn yields at Lincoln in 1955 were larger on stubble mulched land than on plowdd land. A mean of 15 comparisons on land without nitrogen fertilizer showed a stubble mulched corn yield of 26.7 bushels. The plowed land produced a mean yield of 19.6 bushels.

On other plots the effect of nitrogen fertilizer was determined, either as residual from 1954 or from nitrogen fertilizer added in 1955. The yield of corn on stubble mulched land was 31.5 bushels. On the plowed land it was 28.5 bushels.

These results are in line with many previous observations. That is, that stubble mulching in general has its greatest advantage over plowing in regions of limited rainfall or in more humid areas in years of less than normal precipitation.

Indiana

SOMETHING NEW IN SUBSOILING IS TRIED

D. L. McCune, J. M. Spain, and L. D. Meyer, Lafayette.--A new method of subsoiling which shows promise of improving aeration, increasing infiltration (decreasing runoff and erosion), increasing the depth of plant root zone, and more permanently shattering pans is being studied in Indiana. This practice, which has been termed "vertical mulching", involves the placing of organic materials into subsoiler channels. The organic materials so far tried include mature alfalfa hay, corn cobs and a mixture of oat straw and weeds.

A subsoiler standard was fitted with wings to hold the channel open while organic material was blown into the soil by a field chopper (see Figure 1). In this way, up to 2 tons per acre of organic materials were placed into the channel, resulting in a continuous band to a depth of 18-20 inches.

Figure 1. --Machinery used to place organic material into the subsoiler channel

A preliminary trial to compare no subsoiling, subsoiling alone, and vertical mulching was started in August on a sloping Crosby silt loam soil. Two tons per acre of oat straw and weeds were placed in subsoiler channels spaced 80 inches apart. The area is to be planted to corn in 1956.

Observations during a 5-1/2-inch rain over a 3-day period in early October indicated that this band of organic material was effective in increasing infiltration and decreasing runoff. Plots where subsoiling alone was tried were losing considerable water by runoff after only 2-1/2 inches of rain had fallen. (see Figure 2). Only an insignificant amount of runoff was observed on the vertical mulched plots even after the entire 5-1/2 inches of rain had fallen.

Vertical mulching may also have application in drainage. This was indicated during the above mentioned rain when a channel containing organic material was opened to drain and clear water, similar to water from a tile, flowed from it.

Figure 2. --Taken during early October 1955 rainstorm after 2 1/2 inches of rain had fallen. The plot in the foreground was subsoiled only, and water was running off. In the background, the treatment includes subsoiling with crop residues filling the channels. Free water was found in the channel 10-12 inches below the surface.

Illinois

CORN YIELDS NOT SIGNIFICANTLY INCREASED BY SUBSOIL TILLAGE

C. A. Van Doren and R. E. Burwell, Urbana.--Statistically significant increases in corn yield resulting from sub-tillage were secured in only one of 8 field tests in Northeastern Illinois in 1955. A chisel-type sub-tiller was used at 40-inch spacing in these cooperative field tests with the Soil Conservation Service. Three treatments included (1) chiseling to a depth of 10 inches, (2) chiseling to a depth of 16 to 18 inches, and (3) check (no sub-tillage). Treatments were replicated 4 times in a randomized block design on each of the 8 sites.

Ashkum and Drummer are classified as humic glei soils with silty clay loam textures to a depth of 36-40 inches. The structure is granular to a depth of 10 inches. At 18 inches, the structure is medium subangular blocky; however, the structure of Ashkum is slightly more angular at 18 inches and less permeable than the Drummer. These soils have a sticky consistency when wet.

Elliott, Martinton and Symerton soils are imperfectly drained Brunizem soils with heavy silt loam textures at a depth of 10 inches. The Elliott and Martinton are silty clay loams and the Symerton is a clay loam texture at 18 inches. The structure is fine subangular blocky at 10 inches and medium sub-angular blocky at 18 inches.

Yield data for the tests are summarized in the table. Average yield of corn per acre on plots sub-tilled at 10 inches was 2.6 bushels greater than that on the check plots. Plots sub-tilled to a depth of 16 to 18 inches yielded 6.1 bushels more than those not sub-tilled.

On the basis of these data sub-tillage as a practice for corn production on soils of the nature tested would be highly questionable.

Yields of corn as affected by sub-tillage in northeastern Illinois, 1955

Soil type	Corn yield per acre		
	Check	Sub-tilled 10"	Sub-tilled 16-18"
	Bushels	*Bushels*	*Bushels*
Ashkum silty clay loam #1.........	79.3	76.7	83.5
Drummer silty clay loam #1........	70.7	74.3	74.4
Drummer silty clay loam #2........	83.0	84.4	79.7
Drummer silty clay loam #3........	67.9	78.6	75.3
Elliott silt loam #1.............	75.6	77.5	90.2
Elliott silt loam #2.............	48.2	54.3	59.1
Martinton silt loam..............	76.3	74.3	76.7
Symerton silt loam...............	94.0	95.7	105.2*
Averages.........................	74.4	77.0	80.5

*Statistically significant increase at .05 level.

Illinois

STRAIGHT ROWS ALL RIGHT ON TERRACED FIELDS WITH GENTLE SLOPES

H. L. Rhoades and C. A. Van Doren, Urbana.--Three terraces were constructed at the Joliet Station in 1950 on a 4-percent slope of Elliott silt loam with one erosion. Settled dimensions of the terrace cross-section as constructed were: Width - 30 feet, including ridge and channel; channel width - 20.7 feet; channel depth below ridge - 0.68

Effect of farming on terrace cross-sectional area[1]

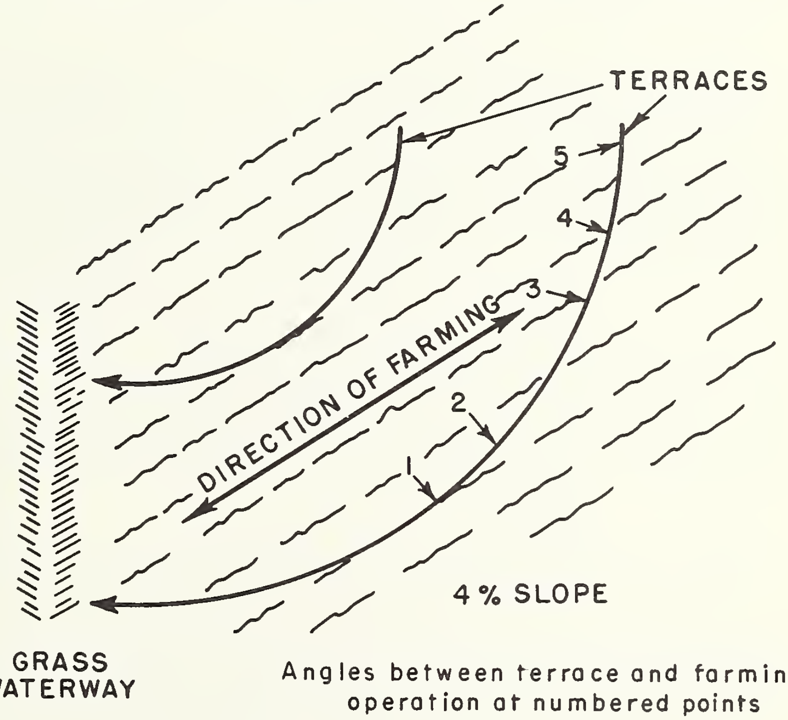
Terrace No.	Average terrace cross-sectional area						Reduction in capacity from May '51 to Feb. '55	
	5/28/51 As Const.	2/7/52 After corn	12/17/52 Oats	11/18/53 Hay	2/9/55 Corn	June/55 After plowing		
	Sq. Ft.	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Percent*
2........	8.08	6.73	5.61	6.07	5.25	12.39	2.83	35
3........	8.74	7.61	7.06	6.65	4.72	12.04	4.02	46
4........	7.10	6.92	5.53	4.98	3.40	11.05	3.70	52

[1] The average percent loss in terrace capacity per year for the 4-year period 1951-54 under the present rotation and farming methods was 11%. Rotation was corn-corn-oats-hay.

feet and channel grade 0.5 foot per 100 feet. The average cross sectional area after settling was 8.0 square feet.

The field has been farmed as follows: 1951 - corn; 1952 - oats and legumes; 1953 - hay; 1954 - corn; and 1955 - corn. All farming operations were performed in a straight line across the general slope of the field. Terraces were crossed at angles of 0 to 60 degrees as shown in the accompanying chart.

The terraces were overtopped during a rain of 4.16 inches in July, 1954. In the spring of 1955 the terraces were plowed separately as individual lands to increase the channel capacity. This operation consisted of moving the soil three times with a two-way plow. The results indicate:



Angles between terrace and farming operation at numbered points
1 - 5°
2 - 15°
3 - 35°
4 - 45°
5 - 55°

1. Drainage type terraces are feasible on gentle slopes in the area.
2. With proper maintenance, terraced slopes can be farmed with row direction on the general contour.
3. For maintenance of terraces farmed with the general slope, each terraced area should either be plowed parallel to the terraces, or if the field is plowed in a straight line across the general slope, the plow should be removed from the ground when crossing the terraces. The terraces should then be plowed as individual lands.

DEEP TILLAGE NOT MUCH HELP TO CORN WITH ADEQUATE RAIN

I. L. Saveson and Z. F. Lund, Baton Rouge.--In many areas of the Mississippi Delta, cotton will suffer severe drouth damage if there is any degree of moisture stress during the growing season. Preliminary studies indicated that this drought susceptibility is usually associated with areas having compacted zones in the upper soil profile. Studies of tillage practices to remove or control this condition are now under way at the Northeast Louisiana Experiment Station at St. Joseph.

Two types of tests are used--one to determine the effect of depths of sub-soiling and the other to ascertain the effect of different methods of deep tillage on soil properties and crop yields. In the first test conventional shallow tillage is compared to chiseling 12 inches deep, 22 inches deep, and 28 inches deep. The deep tillage methods which are compared to the conventional middle-buster are scarifying (using Graham Hoeme 14 inches deep); edging (plowing 18 inches deep, setting the furrow slice on edge); and lifting (using tool bar with sweeps 18 inches deep).

The results of the depth-of-tillage test in Table 1 do not show the positive response to treatment in 1955 that had been experienced in 1954 on Commerce silt loam at the St. Joseph station. Frequent rainfall during the last half of July and throughout August in 1955 insured adequate soil moisture for maximum plant growth. There was a difference in soil moisture charge during the early part of the year and differences in rate of recharge during the summer. There was enough difference in uptake of water during the rains of April and May to carry the plants 4 to 5 days longer than on the conventionally treated plots when they went into the dry period during June.

Table 1.--Corn yield of depths-of-subsoiling test, 1955

Tillage treatment	Corn yield per acre
	Bushels
Conventional................	47.1
12-inch....................	52.8
22-inch....................	56.4
28-inch....................	54.3

Corn yields from different treatments did not differ significantly.

Cotton and soybeans were the indicator crops in evaluating the effectiveness of different methods of deep tillage in loosening compact soil. Adequate moisture throughout the season resulted in very little yield difference between treatments. Edging and lifting brought marked responses in plant growth; the plants on edged plots and lifted plots were much ranker and taller than the plants on the other plots. Lower cotton yields were obtained on the plowed and the lifted plots than on the conventional or the scarified plots. The cotton on conventional and mixed plots, having a retarded growth, set fruit earlier than cotton on edged or lifted plots and ahead of the heavy infestation of boll weevil. It was impossible to maintain adequate control of the boll weevil during the rainy period of late July and August, since the poison was removed from the plants by the frequent rains.

Table 2 is a summary of 3 tests on the St. Joseph station in 1955.

Table 2.--Effect on yields of method of tillage of commerce silt loam with a compact zone in the upper part of the profile, 1955

Treatment	Yield of seed cotton per acre Test 1	Yield of seed cotton per acre Test 2	Yield of soybeans per acre Test 3
	Pounds	*Pounds*	*Bushels*
Conventional...........	3,002	3,014	28.6
Scarified..............	2,898	3,095	
Edged..................	2,753	2,668	
Lifted.................	2,744	2,965	30.8

In 1954 yields of seed cotton on these plots were: Conventional, 2,022 pounds; mixed, 1,817 pounds; edged, 2,614 pounds; lifted, 2,857 pounds.

South Carolina

MULCH-TILLED CROP YIELDS AFFECTED LITTLE BY N PLACEMENT

O. W. Beale and A. W. Snell, Clemson.--The results of several years' testing have shown the effectiveness of mulch tillage in reducing runoff and erosion and improving fertility and crumb structure of the soil. Generally, yield trends have indicated only slight increases are due to mulch tillage and, in some instances, depressions in yields have been noted. One of the major objectives of efforts to develop practical methods of mulch tillage, improvement of yields, has not yet been attained.

Soil organisms temporarily reduce the amount of nitrogen available to plants during decomposition of plant residues and when considerable quantities of plant material are used as mulch or turned under, a critical nitrogen deficiency in the early stages of crop growth might result. Placement of the nitrogen fertilizers out of the zone of plant residue concentrations should minimize this possibility. During some tillage studies, there have been indications that moisture consumption by mulch-tilled crops was somewhat greater than that by clean-tilled crops.

In the test to be reported here, cotton and corn were grown in a two-year rotation of cotton-vetch and rye, corn-vetch and rye. The row crops were planted in the spring and followed by the winter cover crop of mixed vetch and rye. The vetch and rye and crop residues were handled by two tillage methods. Mulch-tilled plots were disk-harrowed and ripped about 6 inches deep, which left most plant residues on the soil surface. The clean-tilled plots were turn-plowed and disk-harrowed to incorporate the cover crop and other plant residues with the soil. Main plots for the comparison of tillage methods were split into 2 sub-plots. In the sub-plots nitrogen side-dressings were placed at depths of 3 inches and 6 inches. There were 6 replicates of each main plot tillage method, three of which were irrigated and three unirrigated. Irrigations were made to recharge the soil to field capacity when the soil moisture was 25% of the available water-holding capacity. Fertilization of corn was uniform for all treatments, 500 pounds of 4-12-12 at planting plus 160 pounds of nitrogen side-dressing per acre. The cotton was fertilized with 800 pounds of 4-12-12 at planting plus 95 pounds of nitrogen side-dressing per acre.

Table 1 shows the effects of these treatments on corn yields. Placement of the nitrogen side-dressings had very little influence on yields from either tillage method, whether irrigated or unirrigated. Soil moisture was not a limiting factor in 1955 and irrigation did not substantially increase yields, regardless of tillage method or placement of nitrogen fertilizer.

The mulched and the plowed-clean-tilled treatments were irrigated July 9 with 1.4 inches of water, this was followed by 0.5 inch of rainfall on July 11. On Aug. 13, the

soil moisture of both tillage treatments had been exhausted to 25% of the available water. The mulch plots were irrigated on this date with 1.4 inches of water, but before the plowed plots could be irrigated, rain began; it totaled 2.4 inches by Aug. 15. Therefore, the irrigation of Aug. 13 on the mulch plots was probably ineffective and did not influence the yields of this treatment.

The average corn yields of the irrigated and unirrigated mulch plots were significantly greater than those of the plowed-clean-tilled.

Table 2 gives the yields of seed cotton. The placement of nitrogen side-dressing had no significant effect on cotton yields. The mulch-tilled cotton was not irrigated during the season; however, the plowed-clean-tilled cotton was irrigated twice--Aug. 6, 1.1 inches; and Aug. 13, 1.4 inches. The irrigation of Aug. 13 was not effective because 2.4 inches of rain fell Aug. 14 and 15. The data indicate that the rate of soil moisture depletion from the mulch treatments was slower than from the plowed-clean-tilled. Quantity and distribution of rainfall was adequate in 1955, and irrigations did not cause significant increases of yields.

Table 1.--Effects of tillage, nitrogen placement, and irrigation on yields of corn

Tillage	Depth of N placement	Irrigations		Yields per acre	
		July 9	Aug. 13	Unirrigated	Irrigated
	Inches	*Inches*	*Inches*	*Bushels*	*Bushels*
Mulch.................	3	1.4	1.4*	95	97
Mulch.................	6	1.4	1.4	90	97
Plowed................	3	1.4	0.0	76	83
Plowed................	6	1.4	0.0	80	82

LSD (.05) = 14 bushels per acre

*Rainfall of 2.4 inches occurred on Aug. 14 and 15, preventing irrigation of plowed treatment. This irrigation was ineffective.

Table 2.--Relation of tillage, nitrogen placement and irrigation to yields of seed cotton

Tillage	Depth of N placement	Irrigations		Yields per acre	
		Aug. 6	Aug. 13	Unirrigated	Irrigated
	Inches	*Inches*	*Inches*	*Pounds*	*Pounds*
Mulch.................	3	0.0	0.0	2,227	2,148
Mulch.................	6	0.0	0.0	2,132	2,187
Plowed................	3	1.1	1.4*	2,228	2,192
Plowed................	6	1.1	1.4	2,388	2,374

LSD (.05) = 584 pounds per acre

*Rainfall of 2.4 inches occurred Aug. 14 and 15. This irrigation was ineffective.

Another test, in which the corn stalks alone were the source of mulch material and residues to be turned under, was conducted with rates and placements of the nitrogen fertilizer as variables. Seedbed preparation for planting the corn was by turn-plowing and disk-harrowing. Residue treatments included placing corn stalks on the soil surface as (1) mulch, (2) disking stalks in about 3 inches deep and (3) turning under stalks. The

control was a no-residue treatment, also prepared for planting by turn-plowing and disk-harrowing. The corn was fertilized with 500 pounds of 4-12-12 per acre at planting. Nitrogen fertilizer side-dressing was applied at rates of 40, 100 and 160 pounds nitrogen per acre. This was placed at two depths, 3 inches and 6 inches. There were no significant differences between any treatments. Average yield for all treatments was 52 bushels of corn per acre.

SOIL AND WATER MANAGEMENT--GENERAL

Nevada

ASPHALT IMPREGNATED DRAINAGE PIPE NOT HARMFUL TO ALFALFA

Lloyd E. Myers, Jr., Reno.--Small scale pot tests have indicated that asphalt impregnated drainage pipe does not affect either yield or root development of Lahontan alfalfa.

Field observations by other workers had indicated damage to certain plants which they attributed to the presence of asphalt. A question was raised concerning possible damage to alfalfa by asphalt impregnated drainage pipe installed in close proximity to the plant roots. A pot study was initiated to obtain information concerning the validity of this question.

Lahontan alfalfa plants were established in soil in clay pots. Conditions were uniform except for the presence of chips broken from asphalt impregnated pipe placed 2 inches below the soil surface in half of them. Top growth was harvested after blooming had begun and was dried and weighed. Roots and crowns were washed free of soil and were dried and weighed. Yield data are presented in the table below.

Yields of Lahontan alfalfa planted in clay pots, with and without asphalt impregnated pipe chips

Test number	Top yields per pot		Root and crown yields per pot	
	With chips	Without chips	With chips	Without chips
	Grams	*Grams*	*Grams*	*Grams*
1....................	9.8	11.7	29.2	28.0
2....................	9.3	8.7	28.4	32.2
3....................	12.8	10.3	36.4	27.9
Average...............	10.6	10.2	31.3	29.4

No significant differences in top growth or in root development were revealed by visual observation. Analysis of the data indicates that yield differences were definitely non-significant. It seems safe to conclude that the presence of asphalt impregnated pipe chips did not retard the growth of alfalfa in the pots.

Texas

BEEF CATTLE PAY THEIR WAY IN COMBINED PRACTICES EXPERIMENT

R. C. Henderson and R. M. Smith, Temple.--In spite of a weak market for finished cattle in the fall of 1955, our integrated program using beef cattle showed some margin above costs.

Financial data are summarized as follows:

Beef cattle financial summary, 1954-55

Average cost of steers per head		$79
(102 head steers at $0.18 pound, average weight -430 pounds; purchased in 1954 as follows: 63 on July 2, 14 on Aug. 26, 25 on Sept. 2.)		
Total cost of cattle plus winter feed per head		$99
Value of 799-pound cattle after grazing, at $0.19 per cwt		$152
Return for grazing* per head		$51
Return for grazing* per acre completely grazed		$31
Feed cost per head in feedlot		$52
Cost of cattle and feed to Dec. 1, 1955		$204
Sale price per cwt. in Fort Worth, Dec. 7 (Average weight 1,038 lbs.)		$21
Sale price per head on Dec. 7, 1955		$213
Margin in feedlot*		$9
Overall margin per head*		$60
Acres completely grazed per head	1.65	
Acres partially grazed per head	1.07	

*These figures do not include cost of growing the grazing crops, labor, interest on investment, veterinary services or other minor miscellaneous items but represent returns above feed, original cost of cattle, hauling and commission for selling. The loss by death of 2 steers is also deducted.

A good margin of $51 per head or $31 per acre was realized from complete grazing. In the feedlot the margin above feed costs was $9 per head. This would probably have paid for the labor in a farm feeding operation where no experimentation was involved.

The 100 head of fat steers were sold after 145 days in the feedlot. These cattle had been fed in 10 separate lots. Stilbestrol was fed to 4 lots. Six lots were fed without stilbestrol, 4 outside the barn and 2 inside.

There was a consistent advantage from the stilbestrol. Based on feedlot weights, the maximum gain came with stilbestrol and unlimited grain. However, for some unknown reason the final carcass weights for this lot were less than for the lot with limited grain. Thus, in this experiment, the extra grain appeared to pay the feeder but not the purchaser.

There were differences in favor of the lots under barn shelter, as well as differences in favor of stilbestrol. All lots fed outside the barn showed slower rates of gain and higher costs per pound of gain than any lots fed under barn shelter.

Tables 1 and 2 show steer gains for the crops grazed in 1955. In Table 2, crop yields in addition to grazing return are given from areas partially grazed. The bermudagrass-buffalograss-cool season pasture (Table 1) was used also in the fall of 1955 for the cattle to be finished in 1956. The total return from the pasture is estimated as about twice that shown in Table 2, because there was heavy growth in July and August which was used for wintering and maintenance from October 1955 through part of January 1956. It is impossible to compute an exact steer gain per acre for this period because it was necessary to feed a protein supplement of cotton-seed meal.

Table 1.--Summary of steer gain from all crops completely grazed in 1955

Type of pasture	Acres	Grazing period	Average daily gain	Steer gain per acre
			Pounds	*Pounds*
Sudangrass.................	15	May 3 to July 13) Aug. 8 to Aug. 16[1]) Nov. 7 to Nov. 11[1])	1.30	166
Bermudagrass-buffalograss with cool season grasses.	44	Feb. 7 to June 9	1.39	125
Barley with clover.........	14	Feb. 7 to May 3) May 26 to June 15) June 30 to July 13) Sept. 1 to Oct. 6[1])	1.70	235
Native grass...............	8	Mar. 7 to Apr. 22) May 31 to June 30)	1.99	125
Oats with clover...........	77	Feb. 7 to July 13) July 22 to Sept. 12 [1])	1.63	186
Miscellaneous.............. (small fields)	7	Feb. thru Sept. (Not continuous)	1.20	94
Acres completely grazed	165			

[1] These gains were from small steers for 1956 feedlot.

Table 2.--Steer gain and yield from crops partly grazed in 1955

Type of crop	Acres	Grazing period	Average daily gain	Steer gain per acre	Harvested yields per acre
			Pounds	*Pounds*	
Sudangrass...........	14	May 3 to May 31) June 9 to July 13) Oct. 6 to Oct. 19[1])	1.44	218	1,700 lbs.hay
Barley with clover...	43	Feb. 7 to Mar. 7) June 24 to July 13) Aug. 22 to Sept. 6[1])	0.98	32	18 bu. barley
Oats with clover.....	42	Feb. 7 to Mar. 7) Sept. 12 to Oct. 14[1])	1.66	51	2,350 lbs.hay (14 acres) 13 bu. oats (28 acres)
KR bluestem with cool-season clovers on eroded land	8	Mar. 17 to Mar. 28) Apr. 7 to May 3) Aug. 26 to Sept. 11[1])	1.61	86	80 lbs. seed
Acres partly grazed	107	(Does not include corn stubble, etc.)			

[1]These gains were from small steers for 1956 feedlot.

Texas

FOR WEED CONTROL ON FALLOW LAND--CHEMICALS OR MULCH TILLAGE?

C. E. Van Doren and Allen F. Wiese, Bushland.--A study on the control of weeds with chemicals during the fallow periods in a wheat-sorghum-fallow rotation was started in the spring of 1955. The purpose of this study is to work out a method of conserving more crop residue on the surface for wind erosion control. Stubble mulch tillage is used as a check against chemical weed control, and two methods of seeding were used for both wheat and sorghum.

Good chemical control of annual grasses and volunteer wheat was obtained with 8 pounds of Dalapon per acre. This herbicide did not control volunteer sorghum. Broad-leaved weeds were chemically controlled with one-half pound of 2,4-D ester per acre.

Texas

SOIL MOISTURE VARIABILITY IS LOW ON "HARDLANDS"

M. E. Jensen, Amarillo.--Soil moisture samples on an irrigated wheat experiment indicate that the Pullman silty clay loam soil on the Amarillo experiment station is uniform in water-holding capacity. The Pullman soil is representative of a large portion of the "hardlands" on the high plains.

The soil was sampled in one-foot segments of the profile with a King tube sampler. The variance due to depth was removed and all other variation was called sampling error. The locations sampled consisted of twelve level plots, each treated uniformly.

The soil moisture content was near field capacity, having been given a preplanting irrigation in September and light applications on October 28 and November 18. The variability in soil moisture is expected to be greater as the crop extracts moisture more rapidly. Standard error of sampling soil moisture gravimetrically as percent of mean soil moisture is given in the following table:

Date	Location	Depth	Standard error in percent of mean soil moisture
10-24............	12	6 Ft.	7.6
11-4.............	12	4 Ft.	4.3
11-17............	8	4 Ft.	2.7
11-25............	8	4 Ft.	3.3
12-13............	8	4 Ft.	3.3
Average			4.2

These values indicate that variability between the sampling locations is extremely low.

South Dakota

MULCHING WHEAT, RYE REDUCES STAND SURVIVAL

Lawrence O. Fine and H. M. Vance, Brookings.--Covering winter wheat and rye late in the fall with 1-1/2 tons per acre of coarse alfalfa straw had a detrimental effect on stand survival.

The experiment was conducted on a Beotia silt loam soil. Crops were planted in rows 12 inches apart; a medium-deep furrow effect was created by the drill. The crop was irrigated twice in the fall and twice the following spring. The residue cover was applied on November 22, and removed in early April.

The yields obtained in the experiment are summarized as follows:

Fertilizer treatment per acre $N - P_2O_5 - K_2O$	Grain yield per acre		
	Rye	Wheat (uncovered)*	Wheat (covered)
Pounds	*Bushels*	*Bushels*	*Bushels*
0-0-0	11.6	13.3	11.5
40-0-0	12.9	14.6	15.1
80-0-0	16.2	14.6	16.5
0-40-0	11.6	13.2	11.6
0-80-0	11.0	12.4	14.4
80-80-0	14.7	17.6	13.6

*Least significant difference (5% level) for fertility treatments in uncovered wheat was 3.6 bushels per acre.

Tillering of the covered plots was sufficient so that yield differences were small.

The stand survival in the spring was estimated to be 70-80% of that in the uncovered plots.

Yields were affected slightly by fertilizer applications, nitrogen being more effective than phosphorus. Fertilizers applied had no effect on winter survival.

Florida

CHLORINATED BENZENES USED AS AQUATIC HERBICIDES DISAPPEAR SOON

John C. Stephens, Ft. Lauderdale.--A summary of experiments indicates that in static water containing 100 p.p.m. herbicides, 30 p.p.m. being chlorinated benzenes, the concentration of chlorinated benzenes decreased to 0.5 p.p.m. or less within 24 hours of the treatment. Within 2 days the chlorinated benzenes were gone. The experiments were conducted at the Plantation Field Laboratory, Fort Lauderdale, and Everglades Experiment Station, Belle Glade, to determine the nature of the dissolution of aquatic herbicides in canal waters. Analyses were made with the aid of the Olin Mathieson Chemical Corporation and Westgate Chemical Corporation.

It was also found that the chlorinated benzenes do not accumulate in the mud of canal bottoms. Tests on a ditch at Fort Lauderdale that had been treated at intervals for 2 years and on ditches at Belle Glade which had been treated for 3 years indicated no chlorinated benzene residue. After a 100 p.p.m. treatment, bottom mud samples contained only between 0 and 1 p.p.m. of chlorinated benzenes within 3 to 6 days after application.

Evaluation of various aquatic herbicides for use in canals has been carried out under Florida conditions for several years. The most promising types for control of submersed weeds, such as naiads, appear to be formulations of aromatic solvents or gasolines containing chlorinated benzenes and a nonionic emulsifier injected under water at 30 to 50 pounds per square inch in 50 to 200 p.p.m. concentrations. These experiments were made to find out if residues were being accumulated in the static water or bottom muds. Periodic samples were taken by ARS and sent to the Olin Mathieson Chemical Corporation Niagara Falls Works Laboratories for ultra-violet analysis to determine traces of polychlorinated benzenes. Data indicate that the loss of the herbicide from the water is by evaporation rather than chemical or bio-chemical disintegration, seepage, or other means.

KUDZU-MERKERGRASS PASTURES PRODUCE 1,100 POUNDS BEEF PER ACRE

Ruben Caro-Costas, Rio Piedras.--An experiment is being carried out at Orocovis to determine the productivity of a kudzu-Merkergrass pasture on steep eroded soil typical of the mountain section of Puerto Rico. The need for periodic mowing of such pastures is being critically studied.

Six 1/2-acre pastures of kudzu-Merkergrass were grazed in rotation for one year by native scrub steers. The animals received no concentrate feed. Each paddock had a salt block containing phenothiazine and was supplied with an abundance of fresh water.

The attached table shows the beef gains produced by each inclosure and the average daily gain made per head during the first year of experimentation. On the average, the pastures produced about 1,100 pounds of beef per acre yearly and carried about two head per acre. The average daily gains per head - 2.1 pounds--compare favorably with those made by beef cattle on good pastures in the continental United States. There was no appreciable difference in productivity between the inclosures that were mowed and those that were allowed free growth.

These results show the high production capacity of kudzu-Merkergrass pastures and the excellent quality of the forage produced by this association. Such pastures can constitute a form of very intensive land use together with conservation on the steep slopes of the mountain region of Puerto Rico.

Gain in weight produced by young scrub steers grazing a kudzu-Merkergrass pasture on steep slopes of an acid, red soil at Orocovis, Puerto Rico, over a one-year period

Pasture No.	Treatment	Gain per acre during year	Average daily gain per head
		Pounds	*Pounds*
1	Free growth	1,020	1.6
2	Mowed	1,278	2.4
3	Free growth	1,401	2.5
4	Free growth	1,251	2.3
5	Mowed	732	2.0
6	Mowed	1,122	1.9
Average		1,117	2.1

Puerto Rico

SUNGROWN COFFEE HOLDS PROMISE OF PROFIT, CONSERVATION

Jose Vicente and Fernando Abruna, Rio Piedras.--Coffee will be grown on the 250,000 acres of land that need the protection this crop affords only if high, profitable yields can be produced there. At present, all coffee in Puerto Rico is grown under shade trees. These compete strongly with the coffee trees for light, nutrients and moisture. Furthermore, their presence greatly complicates the management of coffee plantations. It would seem logical that if coffee can be grown without shade, per acre yields of this crop could be greatly increased.

Several years ago work was started with the aim of determining whether it was possible to grow Arabica coffee in full sunlight in the coffee region of Puerto Rico. It was assumed that the coffee plant is capable of growing in full sunlight and that the problem was to find the proper management practices. An exploratory study showed that the Bourbon variety of Arabica coffee was better suited to growing in full sunlight than were either Common Arabica or Columnaris.

Following this exploratory work, a rather extensive planting was made in full sunlight. The coffee trees were planted close together in two-row hedges with trees 3 feet apart in rows the same distance apart. Approximately 15 feet were left between hedges. The soil between the hedges is protected by a cover crop to prevent erosion. With this system, plant population is about doubled, and the trees shade themselves to some extent. The coffee was heavily fertilized with a complete fertilizer three times a year and the trees sprayed periodically with a fungicide and insecticide to control the pests attacking the above-ground portions.

The trees bore their first crop when three years old and produced approximately 6 hundredweights of market coffee per acre or about four times the island-wide average with mature shade grown coffee. Since coffee trees increase their production until they are 7 to 8 years old, it is expected that yields will increase greatly in future years. Generally, the first crop of shade grown coffee is hardly worth picking.

In view of these promising results, 4 detailed experiments have been laid out to study the lime and fertilizer requirements of sungrown Arabica coffee of the Bourbon variety under conditions typical of the mountain region of Puerto Rico. To date the coffee has responded markedly in growth to nitrogen fertilization. A detailed experiment is also about to be started to determine the effect of various shade levels on coffee yields and growth and some of the relationships between shade and nutrition.

Puerto Rico

MALEIC HYDRAZIDE AND UREA INCREASE PROTEIN IN GUINEAGRASS

Servando Silva, Rio Piedras.--An application of 4 pounds per acre of maleic hydrazide stopped the growth of 40-day-old Guineagrass for a period of about 20 days, immediately following application of this hormone. Application of a urea spray during this period increased the protein content of the grass.

About 40 days after application of a maleic hydrazide spray, when the grass had resumed a normal rate of growth, the protein content of the herbage was appreciably higher than that of untreated grass. This may be explained by the fact that the maleic hydrazide destroyed apical dominance, thus stimulating the production of young lateral shoots having a high protein content.

When Guineagrass was cut a few days after being sprayed with maleic hydrazide, its growth was greatly curtailed for a period of at least 60 days.

The data obtained in this experiment are summarized in the table that follows.

Growth and crude protein content of heavily fertilized Guineagrass sprayed with maleic hydrazide (a) alone and (b) followed by a foliar application of urea[1]

Age of grass	Daily growth of grass per acre[2]		Protein content of grass		
	Not treated	Sprayed with m.h.[3]	Not treated	Sprayed with m.h.[3]	Sprayed with m.h. and urea[4]
Days	*Pounds*	*Pounds*	*Percent*	*Percent*	*Percent*
40.......	35	63	17.1	------------	--------------
50.......	95	0	14.1	13.5	--------------
60.......	104	0	12.7	12.8	15.6
70.......	100	81	10.7	12.3	14.0
80.......	57	40	8.4	10.8	11.9
90.......	45	35	8.2	11.1	12.5
Total	3,400	4,080[5]			

[1] All values are averages of 4 replications.
[2] Dry matter basis.
[3] At the rate of 4 pounds of maleic hydrazide per acre applied when grass was 40 days old.
[4] 200 pounds per acre of urea applied 10 days after maleic hydrazide spray.
[5] Total for grass sprayed with maleic hydrazide and urea--3,800 pounds.

Texas

TIME OF CONCENTRATION ESTIMATED BY NEW FORMULAE

R. W. Baird and Monroe A. Hartman, Waco.--Initial studies have been made to determine the relationship between time of concentration and watershed characteristics for watersheds under observation at this station.

In this study, time of concentration was considered as the uniform or average travel time of the watershed and is the time from center of mass of inflow to center of mass of outflow. Only storms of sufficient duration that the entire watershed was contributing to the flow were used. The time of concentration for these storms was determined from the receding side of the resulting runoff hydrographs as plotted on semi-log paper. For the storm of June 10, 1941, the watershed characteristics including time of concentration, are given in the accompanying table for a representative group of the 30 Waco watersheds.

Various combinations and modifications of the watershed characteristics were tested statistically by means of standard multiple regression methods of correlation. It is recognized that all watershed hydrologic characteristics were not tested. The formulae computed to estimate the time of concentration are as follows:

$$Tc = 5 + \sqrt{A} \quad \ldots\ldots (1)$$

Where Tc = Time of concentration in minutes
A = Size of drainage area in square miles

The error of estimate for all of the watersheds with this formula was 22 percent.

$$Tc = 9.25 + \frac{9.05L}{\sqrt{S}} - \frac{1.55A}{N} \quad \ldots\ldots (2)$$

Where Tc = Time of concentration in minutes
L = Length of water course in miles
S = Land slope in percent
A = Size of drainage area in square miles
N = Surface retardance factor computed by weighting and shown in the table.

The error of estimate for this formula was 12.8 percent.

The computations and plotting of various combinations indicated that the relationship between time of concentration and watershed characteristics changes as the size of drainage area increases. Apparently changes occur at 0.1 square mile, 1.0 square mile, and 10 square miles. These changes suggest an over-all curvilinear relationship, although curvilinear regression methods have not been used. It may be possible to develop a fairly simple relationship by sizes of watersheds rather than attempting to develop relationships for all watersheds at one time.

General observations based on this exploratory analysis indicate the following items may be significant and possibly should be given additional study and consideration:

1. The time of concentration may be a significant factor in determining and/or correlating water yield from ungaged watersheds.

2. It is apparently possible to develop fairly reliable formulas for determining the time of concentration based on watershed characteristics.

3. It may be adequate to determine the time of concentration from sampling channel characteristics and using a weighted uniform bankful velocity with the length of water course.

4. The time of concentration is a measure of watershed characteristics that can be used in computing peak rate of storm runoff, in flood routing and in developing hydrographs from ungaged watersheds.

Comments and suggestions concerning this analysis and the need for additional information on this subject will be appreciated.

Characteristics of representative watersheds

Watershed	Tc, storm of 6-10-41	Retardance factor N*	Drainage area		Length of principal drainage		Average land slope
	Minutes		*Sq. Mi.*	*Acres*	*Ft.*	*Miles*	*Percent*
Y................	61.2	.069	0.483	309	5,040	0.962	2.41
Y-2...............	41.4	.069	0.206	132	3,280	0.621	2.57
Y-4...............	33.4	.076	0.125	79.9	2,760	0.523	2.86
Y-7...............	25.7	.040	0.063	40	1,970	0.373	1.87
Y-10..............	17.8	.054	0.033	21	1,040	0.197	1.88
W-2...............	34.9	.099	0.203	130	3,100	0.587	2.45
W-8...............	24.7	.054	0.063	40.4	2,140	0.405	2.28
W-10..............	18.3	.055	0.031	19.7	1,060	0.201	2.07
SW-3..............	9.0	.040	0.005	3.09	450	0.009	1.91
C.................	107.4	.066	0.905	579	7,760	1.470	2.04
D.................	127.2	.054	1.734	1,110	11,760	2.227	2.10
G.................	192.6	.068	6.844	4,380	25,680	4.864	2.06
J.................	220.8	.071	9.156	5,860	35,800	6.780	2.14

*N--retardance due to cover: Meadow & pasture--0.20, clean tilled--0.04, broadcast--0.10.

Ohio

MEADOWS GET MOST OF THEIR WATER FROM SURFACE 7 INCHES OF SOIL

L. L. Harrold and F. R. Dreibelbis, Coshocton.--Lysimeter data at this station permit evaluation of total moisture extraction from the entire 96-inch depth. In studies of watershed hydrology and irrigation, it is perhaps more important to evaluate moisture extraction rates from the top soil depth--0-7-inches. At Coshocton this 7-inch depth provides the major quickly available reservoir for water storage. It is also the major root zone. Fiberglass-gypsum blocks were used to evaluate moisture fluctuations in the 0-7-inch soil depth (A horizon). The summarized data from irrigated and unirrigated areas appear in the attached table.

Average daily moisture extraction from the 0-7-inch depth of soil on the unirrigated lysimeter during various periods in the growing season ranged from 0.04 to 0.12 inch. On irrigated areas the values for the same periods ranged from 0.05 to 0.16 inch per day.

A comparison of the extraction pattern from the 0-7-inch and 0-96-inch depths on irrigated lysimeter Y102C shows that for many periods most of the soil water is removed from the 0-7-inch depth. The periods of greater moisture extraction from below the 7-inch depth appear to coincide with the dry periods. The unirrigated lysimeter Y103A consistently showed lower average daily consumptive use values in the 0-96-inch layer than did the irrigated lysimeter Y102C.

The period June 29 to September 19 was used to compare consumptive-use values because data for this period were also available from watersheds 109 and 123, both unirrigated but on different soil types. In the 0-7-inch depth the average daily soil-water

extracted was almost identical in amounts from each of the unirrigated areas, both on lysimeters and on watersheds. On the irrigated areas these daily values from both plots and lysimeters also checked very closely. They were appreciably higher than those on the unirrigated areas.

Average daily moisture extraction from irrigated and unirrigated first-year meadow lysimeters in 0-7-inch and 0-96-inch soil depths and from 0-7-inch depth in adjacent watersheds, 1955.

Period	Moisture extracted per day from Muskingum silt loam						Moisture extracted per day from Keene silt loam	
	Not irrigated		Irrigated				Not irrigated	
	Watershed 109 (Top 7 ins.)	Lysimeter Y102A (Top 7 ins.)	D Plots (Top 7 ins.)	Lysimeter Y102B[1] (Top 7 ins.)	Lysimeter Y102C[1] 0-7 ins. of soil	Lysimeter Y102C[1] 0-96 ins. of soil[2]	Watershed 123 (Top 7 ins.)	Lysimeter Y103A (Top 96 ins.)[2]
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
5/19 to 5/25	---	0.09	0.14	0.15	0.16	0.23	---	0.20
7/1 to 7/27	---	.12	.13	.13	.13	.21	---	.17
7/29 to 8/4	---	.08	.10	.13	.12	.21	---	.12
8/11 to 8/22	---	.08	.09	.09	.08	.19	---	.16
8/23 to 9/19	---	.04	.05	.05	.05	.13	---	.11
5/19 to 9/19[3]	---	.09	.12	.14	.14	.19	---	.14
6/29 to 9/19[4]	.102	.106	.130	.137	.135	.177	.101	.136
Yields, tons/acre	4.42	3.96	5.72	5.87	----	5.97	5.65	4.43

[1] Irrigated May 18, 2.25 inches; June 29, 3.01.
[2] Based on weight changes from weighing lysimeters.
[3] Total precipitation for period, 10.97 inches.
[4] Total precipitation for period, 8.08 inches.

Ohio

WATER USE BY CROPS AFFECTED BY YIELD

L. L. Harrold and F. R. Dreibelbis, Coshocton. --The supply of adequate water for agricultural purposes is becoming a problem even in the humid region of the country. The amount of water required for crop growth provides basic information for the farmer and especially for one who aims to supplement his water supply by irrigation. The Coshocton weighing lysimeters provide data on water use for crops grown in a 4-year rotation of corn, wheat, and two years meadow. The weighing lysimeters automatically record weight changes every 10 minutes. From these records, depletion (ET = evapotranspiration) or accretion (CA = condensation and absorption) of soil water can be determined. For periods of no rainfall ET-CA represents the net amount of soil water depletion. Thus ET-CA values are useful in evaluating water use by crops.

The data show that yields vary considerably for the different years for all crops grown in the rotation. When yields are high, more water is consumed but the unit amount of water used per pound of crop is less than for the lower yields. Thus, a 34-bushel-per-acre corn yield in 1945 required 586 pounds of water to produce one pound of crop. In 1953 a 196-bushel-per-acre yield on the same area required only 273 pounds of water to produce one pound of crop. In 1943 a 1.67 ton yield of hay required 1,377 pounds

water per pound of crop, while in 1955 a 4.43 ton yield required only 629 pounds on the same area.

For periods ranging from 6 to 8 years, the average amount of water consumed per pound of crop on the Muskingum and Keene silt loams amounted to 392 pounds for corn, 610 pounds for wheat, 953 pounds for first-year meadow, and 1,094 pounds for second-year meadow. For the same period of years the amount of water transpired and evaporated in producing the crop averaged 21.3 inches for corn, 13.6 inches for wheat, 22.2 for first-year meadow, and 23.3 inches for second-year meadow on the same soil type.

Wisconsin

SOIL MOISTURE MUCH BELOW NORMAL ON FENNIMORE WATERSHEDS

Neal E. Minshall, Madison.--Precipitation in 1955 was the lowest on the Fennimore, Wis., watersheds since they were established in 1938. Precipitation for the last quarter of 1955 was 3.87 inches compared with a normal of 6.50 inches. Total precipitation for the year was 22.56 inches or nearly 10 inches below normal. By mid-September practically all the available moisture had been used to a depth of 3.5 feet. By November 22, when the ground was frozen to a depth of 2 inches, the fall precipitation had replenished the moisture only to a depth of 12 inches under alfalfa and 18 inches under corn. An additional 5 to 7 inches of moisture will be needed after the frost is out in the spring to refill the profile.

Corn yields for the four fields on which soil moisture samples have been taken are tabulated below. With an adequate moisture supply for the plant populations and fertilizer applications, the corn yields on Fields 2, 3 and 4 could easily have been doubled.

Field No.	Field size	Fertilizer applications per acre	Plants per acre	Yield per acre
	Acres		*Number*	*Bushels*
1............	9.5	Manure plus 150 lbs. 3-12-12	10,000	63
2............	36.0	200 lbs. 4-16-16 80 lbs. N side dress	12,000	58
3............	7.5	200 lbs. 4-16-16 80 lbs. N side dress	13,500	48
4............	5.0	400 lbs. 0-20-20 pl. und. 200 lbs. 5-20-20 85 lbs. N side dress	14,000	50

Michigan

HYDROLOGIC AND METEOROLOGIC DATA MAY HAVE WIDE APPLICATION

George A. Crabb, Jr., East Lansing.--Project personnel have been engaged in a study of certain hydrologic and meteorologic phenomena and their daily relations on an annual basis. The purpose of the study is to establish seeding and planting dates of farm and forest crops more closely related to the factors which influence germination and growth. Average annual patterns of precipitation, maximum and minimum temperatures, percent possible sunshine, solar radiation, and other factors have been developed, along with some frequency criteria for precipitation. This study is planned for completion early in 1956.

The project was visited recently by design officials of the automotive industry in regard to sources of insulation data and methods of utilizing such data in the design of automotive air conditioning units.

Virginia

ANNUAL RUNOFF VARIES CONSIDERABLY IN PIEDMONT AREA

James B. Burford and James H. Lillard, Blacksburg. --Rainfall and runoff records for small agricultural watersheds, as indicators of the size of drainage area required to supply small reservoirs for irrigation or stock water purposes, are at a premium these days in Virginia. Applicable data are very scarce, and even short-term records from discontinued stations may be helpful. The available records of annual rainfall and runoff for three small agricultural watersheds near Chatham are given in the following table:

Annual runoff summary, Chatham, Va.

Year	W-I 13.3 Acres			W-II 16.06 Acres			W-III 17.08 Acres		
	Precipitation	Runoff	Runoff of precipitation	Precipitation	Runoff	Runoff of precipitation	Precipitation	Runoff	Runoff of precipitation
	Inches	*Inches*	*Percent*	*Inches*	*Inches*	*Percent*	*Inches*	*Inches*	*Percent*
1939	43.69	5.95	13.61	44.50	10.29	23.12	38.14	6.51	17.06
1940	45.92	5.12	11.14	51.38	13.73	26.72	44.45	7.81	17.57
1941	30.21	.17	.56	29.18	2.06	7.05	31.70	3.02	9.52
1942	44.91	4.83	10.75	46.46	7.21	15.51	43.94	5.00	11.37
1943	30.69	.70	2.28	29.89	1.67	5.58	27.64	1.85	6.69
1944	56.29	9.57	17.00	56.53	14.19	25.10	54.93	11.56	21.04
1945	40.27	1.73	4.30	39.81	4.11	10.32	38.25	4.23	11.05
1946	39.13	.81	2.07	45.29	5.83	12.87	35.24	3.34	9.48
1947	36.61	.65	1.77	38.36	3.14	8.18	40.18	3.88	9.65
Av.	40.86	3.28	8.02	42.38	6.91	16.30	39.38	5.24	13.30

These watersheds are located well within the piedmont plateau problem area. W-I and W-III are within the crystalline rock parent material sub-area and W-II is in the Triassic basin sub-area. They are terraced watersheds representative of the piedmont tobacco farming areas. During the period of the measurements, W-I was 91 percent cultivated, 4 percent woodland and 5 percent in meadow strip. W-II was 97 percent cultivated with 3 percent in a sodded waterway. W-III was 90 percent cultivated, 7 percent woodland and 3 percent in waterway. The crops were tobacco, corn, small grain, hay and pasture with no rotation system followed.

The data show wide variations in annual runoff between watersheds for the same year and extreme variations in the runoff as percent of rainfall between years for each watershed. For the years of low total rainfall there is a trend for a much smaller runoff percentage than for the years of higher rainfall amounts. These records emphasize the acknowledged fact that sufficient storage capacity is good insurance for the water user depending upon ponds or small reservoirs for irrigation or stock water needs.

Florida

NEW BASIN STUDY TO OBTAIN DRAINAGE COEFFICIENTS

John C. Stephens, Ft. Lauderdale.--Very few of the past or present watershed studies are suitable for obtaining data relative to design and operation of drainage systems. At the request of and with the cooperation of the Central and Southern Florida Flood Control District, a rain gage network was established in the upper portions of the watershed of Taylor Creek, Okeechobee County, so that data may be obtained for (1) evaluation of the present rainfall-runoff relations, seasonal and storm, of this typical flatland watershed and (2) evaluation of the effect of farm and areal water control improvements currently being accelerated there. The results of this study will be used in future planning, design, re-design, and operation of water control structures in the lower Kissimmee river basin.

Instrumentation consists of 6 recording rain gages, an evaporation station near the center of the basin, and a lower and an upper stream gaging station.

The drainage area of the basin above the lower gaging station is about 69,000 acres, and that above the upper gaging station is about 11,000 acres. The land is nearly flat to gently rolling with sand and sandy loam soils which range in elevation between 25 and 65 feet above sea level. A relatively impermeable stratum confines artesian water which is found at depths of several hundred feet. Periodic floods and drouths are characteristic of the watershed.

SEDIMENTATION

Mississippi

INSTALLATIONS COMPLETED FOR STUDYING GULLY SEDIMENT PRODUCTION

Russell Woodburn, State College.--During the quarter, a previously planned gully treatment evaluation study was initiated. Work unit conservationists of SCS in Carroll, Tallahatchie, and Lafayette counties cooperated in the installation of three rather extensive gully treatment test areas. They furnished bulldozers for construction of a small sediment-trapping dam in each gully and the complete mulching and planting of each gully.

ARS planned and laid out the work, made all necessary surveys and maps, and will do the sounding and re-surveys of the small basins for determination of sediment production.

Plans call for determination of the effect on gully erosion of mulch, trees, grass, and kudzu in various combinations. Five gully areas were located in Carroll county, 6 in Tallahatchie, and 7 in Lafayette county. These gully areas vary in size from 0.179 to 2.066 acres. Re-surveys will be made at one- or two-year intervals to plot curves of sediment production per unit area of gully versus time.

HYDRAULICS

Colorado

INTERCEPTOR DRAIN MODEL STUDIES SHOW HOW TO ADAPT THEORY

A. R. Robinson, Fort Collins.--The objectives of this study were to check by model techniques the theoretical equations used for determining the shape of water table drawdown curves resulting from the installation of an interceptor drain. A study was also made for determining the resulting discharge into the drain after installation. The problem was investigated using a large laboratory model of an idealized uniformly sloping, homogeneous water-saturated sand. Variables included the slope s, of the

impermeable barrier, the thickness of the water-bearing formation H, the depth of the tile above the impermeable stratum h, and the distance from the drain to the upstream source L. (see figure 1).

It was found that the theoretical formula for determining the drawdown curve for systems where the slope was greater than zero

$$x = \frac{2.303\ H \log (H - h)/(H - y) - (y - h)}{s} \qquad (1)$$

was applicable for systems where the source of seepage supply was at a great distance from the tile installation. In this equation x and y are coordinates at any point on the drawdown curve.

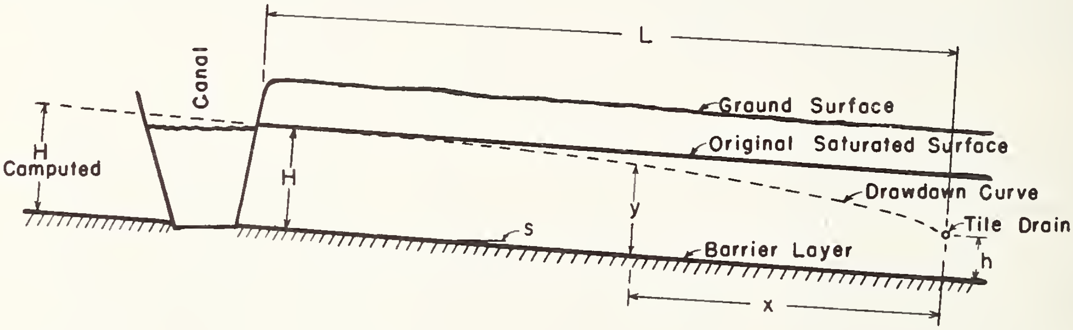


Figure 1 Layout of an Interceptor Drain System

However, in the case where the supply source of seepage was at a finite distance from the drain, i.e. seepage from a canal near which the drain was placed, an adjustment was necessary in the equation in order to accurately determine the drawdown curve. This adjustment, in effect, was an increase in the value of H to some value greater than the depth of water-bearing formation. One method of determining the new value of H is to substitute values into equation (1) using the distance from the drain to the source L as x and the depth of the saturated stratum before drainage as y and solving for H. By using this computed value for H in equation (1) the coordinates of any point on the drawdown curve can be determined with great accuracy.

It was found from the flow analyses that where a drain is intercepting seepage from a source where a constant head can be maintained, such as a canal or lake, and the drain is installed at a short distance from this source, the rate of seepage flow may be increased many fold. The drain must then be designed to carry the original seepage flow as well as the increase in flow due to the installation of the drain. Figure 2 shows this

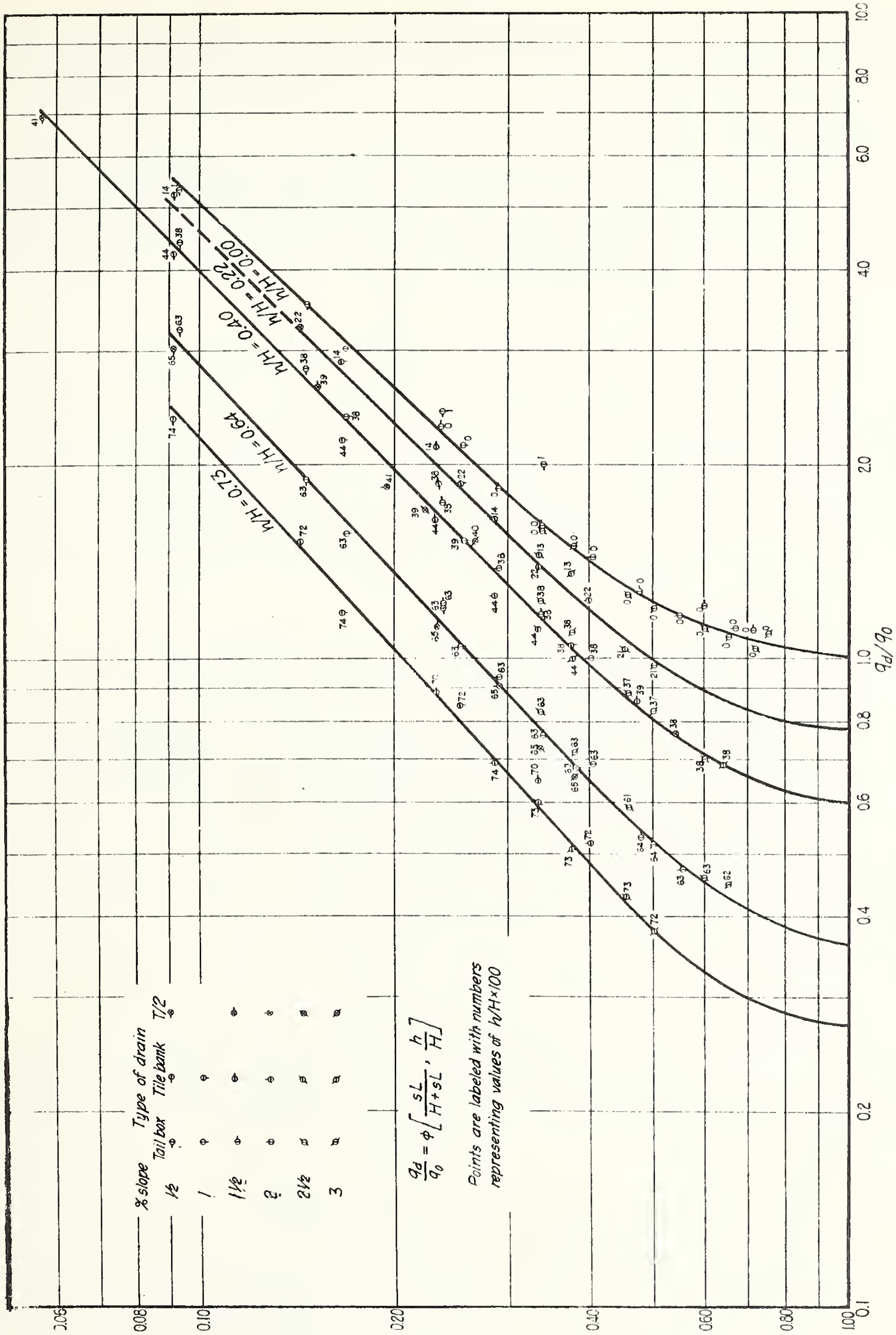


Fig. **2** Discharge of interceptor drains for slopes greater than zero.

relationship. In this plot q_o is the ground water flow per foot of width in the saturated strata before drainage (q_o = kHs). The flow per linear foot in the drain is q_d. The term H is the depth of the saturated strata before drain installation and not the computed value of H.

Here is a practical example:

From field measurements it was determined that the hydraulic conductivity was 3 inches per hour, the slope was 0.01, and the depth of saturated soil was 6 feet. The drain is to be installed on the barrier layer and at a distance of 200 feet from a canal which is the sole source of seepage. In this case the seepage flow before drainage (q_o) would be .0042 cfs (1.9 gpm) per 1000 foot width.

$$sL/H + sL = (.01)(200)/6 + (.01)(200) = .25$$

$$h/H = 0/6 = 0$$

From figure 2, q_d/q_o - 2.2, so the flow in the drain is 2.2 (1.9) or 4.2 gpm per 1000 linear foot of drain. In other words, the seepage from the reach of canal where the drain is installed nearby would be increased by 120 percent.

The investigation also showed that the equation for determining the shape of the drawdown curve for the case where the barrier layer was horizontal was correct. This equation is

$$\frac{H^2 - y^2}{H^2 - h^2} = \frac{L - x}{L} \tag{2}$$

Actual observed experimental data checked very closely with the plot of this equation.

The experiment also answered a question that has arisen regarding the shape of the free water surface downstream from the tile installation. It was found that there was a very slight recovery in piezometric head after which the ground water surface remained essentially parallel to the barrier layer. The recovery was of such small magnitude that it was barely discernible from piezometer readings.

It should be pointed out that these tests were conducted using a material having a capillary rise of less than 2 inches. The effects of capillarity on the shape and flow analyses were not determined.

Oklahoma

PROLONGED WETTING IMPROVES VEGETAL CHANNEL LINING

W. O. Ree, Stillwater.--Disposal of both irrigation waste water and flood flows is a problem often encountered with hillside irrigation systems. Can the same waterway serve both needs--or will waste water trickle flows of long duration weaken the protective vegetation and soften the channel bed so that it will be susceptible to damage by flood flows? In order to get an idea of the answer to this question, a simple experiment was run at the laboratory.

Small bunches of Reed's canary grass were planted on one-foot squares on the bottom of an existing Bermuda-grass channel in a heavy clay loam soil. A low flow of water was then admitted and allowed to run continuously for 60 days. This flow was about 2 inches deep and spread out over about 3 feet of the channel bottom. The water was shallow and did not cover the grass. At the end of 60 days the wetted part of the channel appeared as a bright green stripe on a background of brown. The Reed's canary plantings (made in August) survived and thrived and so did the Bermuda-grass. The channel bed in this area was so soft a 3/8-inch-diameter rod was easily pushed into the soil to a depth of 2 feet. This was the condition of the waterway when the test flood flows were admitted.

Detailed analyses of the data have not been made, but it was readily apparent that the prolonged wetting had not weakened the channel but had strengthened it. Closer examination of the channel and the cover disclosed one of the reasons for this improvement. The long submergence of the base of the grass plant caused the growth of a myriad of fine roots at the surface. This mass of roots around the Reed's canarygrass was 3 inches thick in some places. The Bermuda-grass had a similar growth but probably not as dense. It was difficult to separate the two to be certain of this. Evidently the additional surface root growth added to the protective ability of the grass cover.

This one experiment does not permit formulating any general rules for design, but it does indicate that, under conditions similar to the test, such dual purpose waterways are possible.

<u>Minnesota</u>

SCOUR AROUND HOOD INLET ELIMINATED BY PROPER DESIGN

Fred W. Blaisdell, St. Anthony Falls, Minneapolis.--Scour at the hood entrance to closed conduit spillways results from the very high velocities close to the entrance. Since velocities at the sharp corner are theoretically infinite, it is theoretically possible to lift riprap that is infinite in size and weight. Fortunately, the velocity decreases rapidly with distance away from the inlet. Nevertheless, very large stones were picked up from just below the crest of the laboratory hood inlet and carried through the pipe. It may be hard to realize, but it is possible for stone having a diameter in excess of the pipe diameter to be picked up if the discharge is high enough.

Tests were run to determine:

1. The maximum diameter of the scour hole, which also gives the minimum area requiring protection from scour if erosion is to be prevented.
2. The depth of the scour hole, which also gives the height of the hood inlet crest above the dam face if erosion of the dam face is to be prevented.
3. The size of stone required to prevent scour.

The pipe was full in each case with the head over the hood inlet crest equal to approximately 1.5 pipe diameters. The pipe slope was 20%. Four discharges were used: $Q/D^{5/2}$ = 3, 5, 10, and 15. Furthermore, eight sand sizes were used. These sizes are given in the following table, the mean size being given in millimeters, inches, and pipe diameters. The range of size for each sand is also given, which indicates that the sands were generally quite uniform in size with both fine and coarse material removed.

Sand	Size range	Mean size		
		mm.	*in.*	*pipe dia.*
B.................	0.06 mm.--0.3 mm.	0.15	0.006	0.0026
A.................	0.7 mm.--1.2 mm.	0.9	0.035	0.016
C.................	2.2 mm.--4.0 mm.	3.0	0.12	0.052
D.................	1/4"--1/2"	9.5	0.37	0.17
E.................	1/2"--3/4"	16.	0.63	0.28
F.................	3/4"--1-1/4"	25.	1.0	0.44
G.................	1-1/4"--1-3/4"	38.	1.5	0.67
H.................	2"	51.	2.0	0.89

Twenty-two test runs were made with the dam slope 1 on 3.37. Twenty-four test runs were made with a berm 4.22 pipe diameters wide at the inlet invert elevation.

Considerable scatter of the data is characteristic of scour tests. For this reason, the relative lack of scatter of data for the tests with the berm was a pleasant surprise. It is recognized that this is undoubtedly fortuitous, but the obtaining of quite well-defined curves was welcomed. The data obtained without the berm showed more scatter but generally followed the curves previously obtained with the berm.

The curves were reduced to equations which were put on a dimensionless basis by making all dimensions proportional to the pipe diameter.

The radius of the scour hole on the berm is

$$\frac{\text{Scour hole radius}}{D} = \left(0.15 + 0.04 \frac{Q}{D^{5/2}}\right) \left(\frac{D}{d}\right)^{1/5}$$

where D is the pipe diameter in feet, Q is the discharge in cubic feet per second and d is the grain size in feet. The upstream length of the scour hole without the berm was somewhat less than given by this equation, so the dimensions computed on the basis of the berm will be safe when no berm is used.

It should be especially noted that the equation gives the scour hole radius. If a safety factor is applied, the area to be protected from scour would be somewhat greater than that given by the equation.

The scour hole depth is given by the equation

$$\frac{\text{Scour hole depth}}{D} = \frac{1}{20} \frac{Q}{D^{5/2}} - \frac{d}{D} - 0.075$$

This equation also gives the height of the hood inlet crest above the dam face or above the berm which is required if scour is to be prevented.

Here again it should be noted that the depth of the scour hole and the elevation of the hood inlet crest above the dam given by the equation are minimum dimensions. For safety, the hood inlet crest should be placed higher above the dam face than is indicated by the equation.

At the conclusion of the tests, the scour hole depth for $Q/D^{5/2} = 10$ and sand C was computed. The hood inlet crest was set at this distance above the dam face. Tests were run with and without the berm. No scour was observed during either test.

The grain size for imminent movement is given by the equation

$$\frac{d}{D} = \frac{1}{20} \frac{Q}{D^{5/2}} - 0.075$$

This equation also gives the size of riprap that barely remains in place. The actual riprap size should, of course, be considerably larger--say two or more times as large as the size given by the equation. Furthermore, the riprap should be placed on end so as to expose as little area as possible to uplift forces. Small stones to fill spaces between large stones on the surface are not recommended, as they will likely be picked up and carried through the pipe. An inverted filter is suggested as being desirable. Smaller stone can be used farther away from the hood inlet invert. Safe size of stone and its distance from the invert can be determined from the equation for scour hole radius, modified to allow for the proper safety factors.

An observation during the experiments will emphasize the importance of adequate riprap size. A stone 1-3/4 in. in diameter was picked up from below the invert and carried through the 2-1/4 in. pipe used for the tests. A heavy 2-inch stone, having a density of about 2.9, remained in place during the tests, but it was picked up when disturbed slightly and was carried through the pipe, smashing the inlet in the process.

On the basis of previous work reported by others, it is believed that the results summarized can be scaled up to field sizes with assurance of reliable predictions of scour hole diameter, scour hole depth, and minimum stone size.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of Soil and Water Conservation Research Branch are listed below. The list does not include about 30 items appearing in Water, the Yearbook of Agriculture, 1955, nor does it intentionally include papers for which complete references were given in "Toward Meeting Soil and Water Conservation Research Needs," response of Agricultural Research Service to report submitted by Soil Conservation Service, under date of December 1, 1955.

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